50541

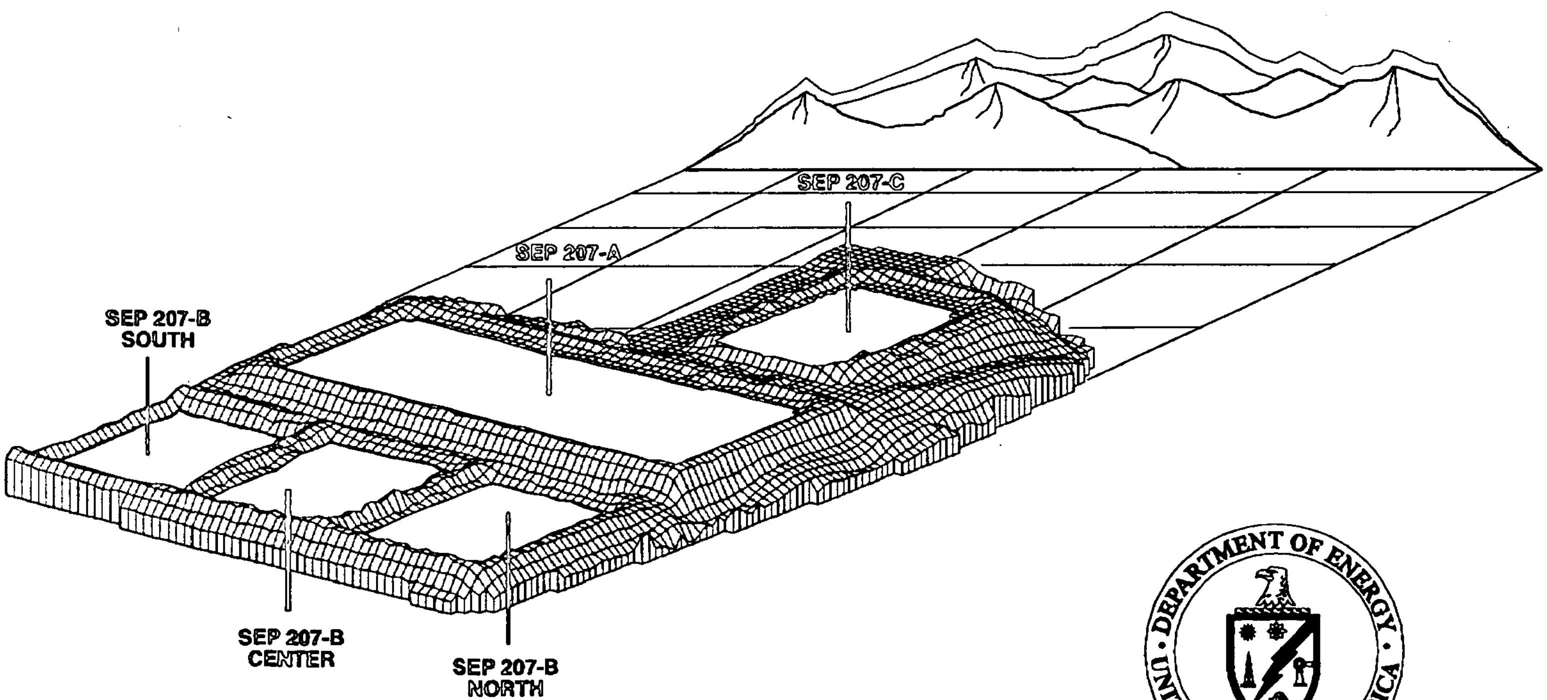
OU4 Solar Evaporation Ponds Interim Measure/Interim Remedial Action Environmental Assessment Decision Document

U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

February 1995

Revision: Proposed

Part I



ADMIN RECORD

A-OU04-000713

OU4 Solar Evaporation Ponds
Interim Measure/Interim Remedial Action
Environmental Assessment
Decision Document

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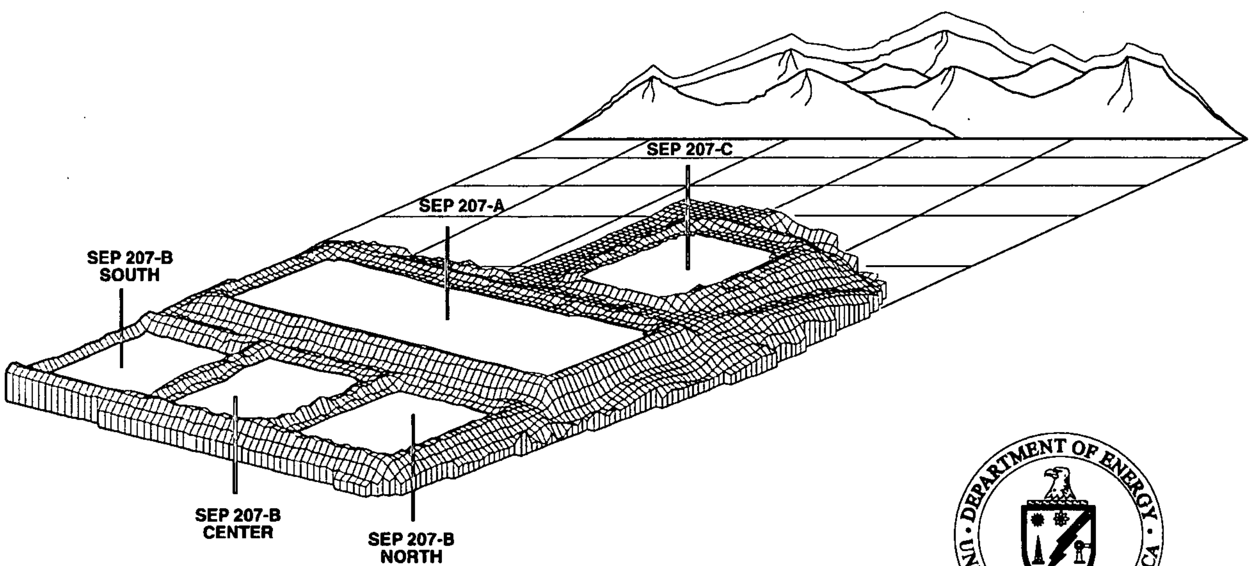

DOCUMENT ORGANIZATION

Operable Unit 4 Solar Evaporation Pond Interim Measure/Interim Remedial Action - Environmental Assessment Decision Document

OPERABLE UNIT 4 SOLAR EVAPORATION POND INTERIM MEASURE/INTERIM REMEDIAL ACTION - ENVIRONMENTAL ASSESSMENT DECISION DOCUMENT

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APPENDICES

OPERABLE UNIT NO. 4
LIST OF ACRONYMS AND ABBREVIATIONS

ADT	Average Daily Traffic
AG	aboveground
AIP	Agreement in Principle
ANOVA	analysis of variance
APEN	Air Pollution Emission Notice
AR	Treatability Studies Annual Reports
ARAR(s)	Applicable or Relevant and Appropriate Requirement(s)
ARF	Airborne Release Fraction
ASTM	American Society for Testing and Materials
ATM-m^3/mole	Atmospheres per cubic meter per mole
ATSDR	Agency for Toxic Substance and Disease Registry
BDL	Below (analytical) Detection Limit
bgs	below ground surface
BRA	Baseline Risk Assessment
BTEX	benzene, toluene, ethylbenzene, and xylene
CAD/FAD	Corrective Action Decision/Final Action Decision
CAMU	Corrective Action Management Unit
CAP	Cement Asbestos Pipe
CCR	Colorado Code of Regulations
CD	Consolidated-Drained
CDH	Colorado Department of Health
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CEC	Cation Exchange Capacity
CE	Cognizant Engineer
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CHWA	Colorado Hazardous Waste Act
CI	Cast Iron
CLP	Contract Laboratory Program
CLT	Comprehensive list of technologies/process options
cm^2	square centimeters
cm/day	centimeters per day
cm/sec	centimeters per second
CMP	corrugated metal pipe
CMS/FS	Corrective Measures Study/Feasibility Study
COC(s)	contaminants of concern
COEM	Conduct of Engineering Manual
COL	colluvium
cpm	counts per minute

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

CRDL	contract-required detection limit
CRQL	contract-required quantitation limit
CSI	Construction Specifications Institute
CU	consolidated-undrained
DCF	dose conversion factor
DCG	derived concentration guide
DCN	document change notice
°C	degrees Celsius
DOE	United States Department of Energy
DOT	United States Department of Transportation
dpm	disintegrations per minute
dpm/kg	disintegrations per minute per kilogram
DQO	data quality objective
DQR	data quality requirement
DRCOG	Denver Regional Council of Governments
EA	environmental assessment
ECD	electron capture detector
EE	Environmental Evaluation
EIS	Environmental Impact Statement
EM	electromagnetic
EMD	Environmental Management Division
EPA	United States Environmental Protection Agency
EPRI	Electric Power Research Institute
ES&H	Environmental Safety and Health
°F	degrees Fahrenheit
FDC	frequency domain capacitance
FFCA	Federal Facilities Compliance Agreement
FID	Flame Ionization Detector
FIDLER	Field Instrument for the Detection of Low Energy Radiation
FML	flexible membrane liner
FO	field operations
FR	Federal Register
FRP	fiberglass reinforced plastic
FS	Feasibility Study
FSP	Field Sampling Plan
ft/ft	feet per foot
ft msl	feet above mean sea level
ft/yr	feet per year

g/cm^3	grams per cubic centimeter
GC/FID	gas chromograph/flame ionization detector
GCL	geosynthetic clay liners
GIS	Geographic Information System
gpm	gallons per minute
GPR	ground-penetrating radar
GRA	General Response Action
GRRASP	General Radiochemistry and Routine Analytical Services Protocols
HEAST	Health Effects Assessment Summary Table
HELP	Hydrologic Evaluation of Landfill Performance
HEPA	High-Efficiency Particulate Air
HHEM	Human Health Evaluation Manual
HHRA	Human Health Risk Assessment
HHS	Human Health Standard
HM	hot measurement
HQ	hazard quotient
HSU	hydrostratigraphic unit
IAG	Interagency Agreement
ICP	Inductively Coupled Plasma Arc Method
ICR	Incremental Cancer Risk
IDL	instrument detection limit
IDM	Investigation-Derived Material
IHSS	Individual Hazardous Substance Site
IM/IRA	Interim Measure/Interim Remedial Action
IRIS	Integrated Risk Information System
ITPH	interceptor trench pump house
ITS	interceptor trench system
K	hydraulic conductivity
KAL	Cretaceous Arapahoe/Laramie
KS	Kolmogorov-Smirnov
LDR	land disposal restriction
LHSU	lower hydrostratigraphic unit
LOEL	Lowest Observed Effect
m	meter
MCL	maximum contaminant level
MEPAS	Multimedia Exposure Pathway Assessment System

OPERABLE UNIT NO. 4
LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

μg/kg	micrograms per kilogram
mg/kg	milligrams per kilogram
μg/L	micrograms per liter
mg/L	milligrams per liter
m/yr	meters per year
MHz	megahertz
mph	miles per hour
MTR	Minimum Technology Requirement
NAAQS	National Ambient Air Quality Standards
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NOE	No Observed Effect
NPDES	National Pollutant Discharge Elimination System
NRC	United States Nuclear Regulatory Commission
NSC	Non-safety Class
NTGS	National Technical Guidance Series
NTS	Nevada Test Site
O&M	operations & maintenance
OPWL(s)	Original Process Waste Line(s)
OU	Operable Unit
OU4	Operable Unit 4
PA	Protected Area
PAH	Polynuclear or Polycyclic Aromatic Hydrocarbon
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCBs	polychlorinated biphenyls
pCi/l	picocuries per liter
PCOC(s)	potential contaminant(s) of concern
PCE	Tetrachloroethene (Perchloroethylene)
pH	negative log hydronium ion concentration (moles per liter) (potential of hydrogen)
PID	photoionization detector
PM1O	particulate matter less than 10 microns
PMR	Power Modification Request
PNA	polynuclear aromatic hydrocarbons
PNL	Pacific Northwest Laboratory
PP	proposed plan
PPCD	DOE's Plan for Prevention of Contaminant Dispersion
PPE	personal protective equipment

OPERABLE UNIT NO. 4
LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

PQAP	Project Quality Assurance Program Plan
PRG(s)	preliminary remediation goal(s)
PSZ	Perimeter Security Zone
PVC	polyvinyl chloride
QA	quality assurance
QAA	Quality Assurance Addendum
QAP	Quality Assurance Plan
QAPjP	Quality Assurance Project Plan
QC	quality control
QAA	Quality Assurance Addendum
RA	remedial action
RAAMP	Radiological Ambient Air Monitoring Program
RAGS	Risk Assessment Guidance for Superfund
RAS	Routine Analytical Services
RCRA	Resource Conservation and Recovery Act
RF	respirable fraction
RFA	Rocky Flats Alluvium
RfC	reference concentration
RfD	reference dose
RFEDS	Rocky Flats Environmental Database System
RFETS	Rocky Flats Environmental Technology Site
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RL	reporting limit
ROD	Record of Decision
ROI	Radiological Operating Instruction
RQD	Rock Quality Designation
RSP	Respirable Suspended Particulates
SAP	Sampling and Analysis Plan
SAS	Special Analytical Service
SCS	Soil Conservation Service (United States Bureau of Land Management)
SEP(s)	Solar Evaporation Pond(s)
SF	slope factor
SOP	Standard Operating Procedure
SOW	Statement of Work
SPT	Standard Penetration Test
SS	stainless steel
SSH&SP	Site-Specific Health and Safety Plan
STL	steel

STP	Sewage Treatment Plant
SVOC	semivolatile organic compound
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TBC	To-Be-Considered
TCA-1,1,1	Trichloroethane
TCE	Trichloroethene
TCL	Target Compound List
TCLP	toxicity characteristic leaching procedure
TDR	Time Domain Reflectometry
TDS	total dissolved solids
TICs	tentatively identified compounds
TMTS	Temporary Modular Tank System
TOC	total organic carbon
TPY	tons per year
TSDF	Treatment, Storage, or Disposal Facility
TSP	Treatability Studies Plan
TSS	total suspended solids
UCL	upper confidence level
UG	underground
UHSU	upper hydrostratigraphic unit
USACE	United States Army Corps of Engineers
USCS	Unified Soil Classification System
UTL	upper threshold limit
UV	ultraviolet
VCP	vitrified clay pipe
VFA	Valley Fill Alluvium
VOC	volatile organic compound
WARP	Well Abandonment and Replacement Program
WCS	weathered bedrock
WQPL	water quality parameters list
WRS	Wilcoxon Rank Sum
ZPA	Zero Period Acceleration

EXECUTIVE SUMMARY

This Decision Document was prepared to request community input and Colorado Department of Public Health and the Environment (CDPHE) and U.S. Environmental Protection Agency (EPA) Region VIII approval to close Operable Unit 4 (OU4) at the U.S. Department of Energy's (DOE's) Rocky Flats Environmental Technology Site (RFETS) in Jefferson County, Colorado. The OU4 closure consists of the Solar Evaporation Ponds (SEPs), which are identified collectively as Individual Hazardous Substance Site (IHSS) Number 101, and IHSS 176 which was annexed by OU4 to implement the Interim Measure/Interim Remedial Action (IM\IRA). The SEPs were used primarily for the temporary storage and evaporation of radioactive process wastes and neutralized acidic wastes containing aluminum hydroxide with high levels of nitrate. Operation of the SEPs has resulted in contamination of the surrounding soils, and the SEPs may provide a source of ground water contamination. The process waste contents of the SEPs (e.g., wastewaters, sludges, and pondcrete) have been removed via separate projects so that the liners and soils beneath the SEPs could be characterized. These SEP contents will be processed as necessary for disposition as a component of this IM/IRA program.

Under the Interagency Agreement (IAG), a Federal Facility Agreement and Consent Order dated January 22, 1991, DOE is required to close and remediate OU4 in accordance with an approved two-phase IM/IRA program. The Phase I program addresses the characterization of the SEP components, liners, pondcrete, sludge, and soils, and the selection of a closure/remediation alternative. Building 788 is located between SEP 207-A and SEP 207-C. Building 788 and its ancillaries are defined as hazardous waste units 21 and 48, and will be closed as part of the IM/IRA due to their proximity to the SEPs, the extent of excavation required for the IM/IRA response actions, and the eventual closure requirements for the RCRA units. Building 964 (RCRA Unit 24), located in IHSS 176, may also be closed as a function of the IM/IRA due to its interference with implementing the IM/IRA. The Phase II program as specified in the IAG Statement of Work, Section I.B.11.6, will evaluate more fully the nature and extent of any contaminant releases from the SEPs, and will determine the added risk (if any) associated with these contaminant releases. Phase II will consist of a Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) conducted separately to determine the risk associated with the contamination at OU4, and will assess the need for ground water remediation. The Phase I IM/IRA program is implemented to provide a RCRA closure action for the SEPs. This Decision Document is a RCRA Class III permit modification request initiated by the DOE to gain approval to implement all the activities proposed in the IM/IRA-Environmental Assessment (EA) Decision Document. The EA component of this document is presented to comply with the National Environmental Policy Act (NEPA) requirements. The final Comprehensive Environmental Response, Compensation, and Liabilities Act (CERCLA) Record of Decision (ROD) and the concurrent RCRA Corrective Action Decision (CAD) for the SEP remediation/corrective action will be issued at the conclusion of the Phase II program.

The RFI/RI for soils and contaminant sources has been completed to fulfill the Phase I investigation requirements of the IAG Statement of Work Section I.B.11.6. The results of the investigation are presented in Part II of this document. Based on data from this and previous investigations, various IM/IRA general response actions have been identified and evaluated to:

- Close the SEPs in accordance with the Colorado Hazardous Waste Act (CHWA) interim status closure requirements for hazardous waste surface impoundments; (6 CCR 1007-3, 265.228; Closure and Post-Closure Care for an Interim Status Surface Impoundment, and 6 CCR 1007-3, 265.111; Interim Status Facility Closure Standards);

- Remediate the OU4 sources of contamination to protect human health and the environment from unacceptable exposure to contaminants via direct contact, inhalation, or ingestion pathways, and to eliminate migration pathways to surface water and ground water. In addition, the closure is required to provide reasonable assurance that the ground water will be protected from further adverse impacts; and

- Provide closure of the SEPs that will be compatible with the final Corrective Action Decision/Record of Decision for OU4.

IM/IRA general response actions (GRAs) that were potentially applicable to the closure of OU4 are identified and evaluated in Part III of this IM/IRA-EA Decision Document. Figure ES-1 shows the various alternatives that were considered. These alternatives present a wide range of actions; including no-action, closure of the units leaving contaminated materials on-site under an engineered cover, closure of the units via *in situ* treatment, excavation of all contaminated materials for *ex situ* treatment with offsite disposal, and excavation of all contaminated materials for ex-situ treatment and consolidation within OU4. The no action alternative addresses minimal efforts to close the SEPs (backfill and seed) with subsequent treatment of sludge and pondcrete for offsite disposal. Table ES-1 presents summary results of the detailed evaluation of the applicable alternatives (GRAs) based on the comparison of risk. Table ES-2 presents summary results of the detailed evaluation of the GRAs based on a comparison of their implementation schedules. Table ES-3 presents summary results of the detailed evaluation of the GRAs with respect to cost. The costs of these alternatives address the closure of the SEPs, remediation of contaminated soils, and the disposition of sludge, pondcrete, and debris associated with the SEPs.

Based on the results of the RFI/RI and the comparative evaluation of the various IM/IRA GRAs, DOE recommends that the SEP liner materials, sludge, pondcrete, contaminated debris, and contaminated soils (from both beneath and adjacent to the SEPs) be consolidated and isolated from the environment under an engineered cover located within the OU4 boundaries. Original SEP wastes (sludge and pondcrete) will be processed as necessary for consolidation with the remaining liners, soils, building equipment and debris for disposition beneath the engineered cover. The DOE requests that a Corrective Actions Management Unit (CAMU) be established to consolidate the remediation-derived wastes beneath the engineered cover. A Temporary Unit (TU) is requested for processing the sludge and pondcrete on the existing hazardous waste storage pads. Soils beneath IHSS 101 and a portion of IHSS 176 will be excavated to the mean seasonal high ground water table elevation and dispositioned beneath the engineered cover. The soils outside the two IHSSs within the OU4 remediation boundary will be excavated to the extent that contaminant of concern (COC) concentrations exceed the applicable preliminary remediation goals (PRGs). All the excavated soil will be dispositioned beneath the engineered cover. The engineered cover will extend primarily over a portion of the SEP boundaries and over most of IHSS 176. SEP liners, sludges, pondcrete, and debris that can not be decontaminated will be consolidated beneath the engineered cover. The rationale for selecting the recommended alternative is also presented in Part III of the IM/IRA-EA Decision Document. Part IV of the IM/IRA-EA Decision Document provides a description of the conceptual design and implementation plans for the recommended IM/IRA. The monitoring activities that will be conducted to assess the performance of the recommended IM/IRA and to comply with the expected RCRA/CHWA post-closure care requirements are described in Part V of the IM/IRA-EA Decision Document. The DOE considers that the proposed IM/IRA provides the highest level of risk reduction at a reasonable cost, as demonstrated by Table ES-1. The Phase II follow-on studies will be conducted as a separate project. If the Phase II RFI/RI results call for additional actions, a detailed analysis of remedial alternatives for the ground water exposure pathway will be conducted (via a separate project).

This IM/IRA, through the use of an engineered cover, is expected to be protective of human health and the environment for a 1,000-year period in conformity with the Colorado Hazardous Waste Landfill Siting Act (6 CCR 1007-2, Part 2). The cover component of the engineered system is based on research focusing on 1,000-year barriers that has been developed at the DOE Hanford Reservation and on engineered cover research from the DOE Los Alamos National Laboratory. The design uses the natural process of evaporation and transpiration to remove infiltrating precipitation from the system. The engineered cover will be constructed from natural materials with long-term durability. Figure ES-2 presents a cross section of the proposed engineered cover identifying each layer and its function. A subsurface drainage layer will be installed at the elevation of the mean seasonal high ground water table elevation to prevent the potentially rising ground water from contacting the consolidated contaminated materials. The results from the performance modeling for the engineered cover predict that the consolidated contaminants beneath the engineered cover will leach at a very slow rate. The leachate concentrations will be at levels that will not have adverse impacts to human health or the environment. A post-closure monitoring system will be installed to provide an early warning if the engineered cover fails, creating the potential for leachate to migrate into the ground water. The post-closure monitoring system will monitor the performance of the engineered cover, the unsaturated soils beneath the engineered cover, and the ground water at the edge of the engineered cover.

The selected alternative will be implemented so that additional waste requiring storage, treatment, or disposal is minimized. The OU4 RFI/RI drill cutting wastes will be consolidated beneath the engineered cover. Utility debris, Building 788 debris, and Building 964 debris that cannot be effectively decontaminated will also be consolidated beneath the engineered cover.

The EA component of this document was prepared to determine if the implementation of the proposed IM/IRA would result in adverse impacts to the environment. The analysis demonstrates that the installation of the proposed final engineered cover, in conjunction with the subsurface drain system, will not adversely impact the OU4 environment and the environment surrounding the RFETS.

In summary, the combination of the subsurface drainage system, which prevents the groundwater from contacting the consolidated contaminated media and the engineered cover, which significantly reduces the infiltrating precipitation as well as shielding both human and ecological receptors from coming in contact with the consolidated contaminated media will provide adequate protection to human health and the environment for 1000 years. This waste containment system, in conjunction with the post-closure monitoring system, will provide a final remedy for the OU4 sources and soils which is protective of human health and the environment.

ES-5

OU4 Closure/ Remediation Scenarios	Remedial Types	Technologies	Descriptions	Screening Comments
No Action	None	Not Applicable	No action	Used as the baseline for detailed analysis
Containment	Monitoring	Ground Water Monitoring	Ongoing monitoring of wells	Potentially applicable
		Vadose Zone Monitoring	Ongoing monitoring of lysimeters	Potentially applicable
	Closure	Temporary Cover	Tarpaulin cover to minimize infiltration and erosion	Potentially applicable
		Engineered Cover	Clay and possibly synthetic-membrane-covered soil	Potentially applicable
Removal	Packaging	Containerization	Packaging of waste for storage/disposal	Potentially applicable
	Excavation	Mechanical	Contaminated media removal with standard earthmoving equipment	Potentially applicable
Ex Situ Treatment	Physical/Chemical Treatment	Degradation	Chemical or biological transformation of contaminants to be less toxic or less mobile	Potentially applicable
		Size Reduction	Mechanical operation to divide objects into smaller pieces	Potentially applicable
		Solidification/Stabilization	Contaminants encapsulated and/or chemically stabilized	Potentially applicable
		Soil Washing	Physical/chemical separation of contaminants from the soils	Potentially applicable
		Solvent Extraction	Dissolving of contaminants from the soils into the solvent fluid	Potentially applicable
		Adsorption	Removal of contaminants from the liquid phase to the solid phase	Eliminated: High cost
		Precipitation	Contaminants become insoluble with addition of chemicals	Eliminated: Difficult to implement
		Organic Polymerization	Stabilization of organic wastes using reactive polymers	Eliminated: Schedule restrictions and high cost
	Thermal Treatment	Incineration	Combustion of contaminants in oxygen	Eliminated: High cost; only organics treated
		Thermal Desorption	Volatilize organics with secondary treatment	Potentially applicable
		Vitrification	Fusion of solid materials into a glass-like product	Eliminated: Schedule restrictions and high cost
In Situ Treatment	Physical/Chemical Treatment	Adsorption	Removal of contaminants from the liquid phase to the solid	Eliminated: High costs
		Degradation	Chemical or biological transformation of contaminants to be less toxic or less mobile	Eliminated: Low soil permeability
		Electrokinetics	Removal of ionic or charged species from soils	Eliminated: Low soil permeability
		Precipitation	Contaminants become insoluble with addition of chemicals	Eliminated: Low soil permeability
		Soil Flushing	Leaching of contaminants from the soils into the flushing fluids	Eliminated: Low soil permeability
		Solidification/Stabilization	Contaminants encapsulated and/or chemically stabilized	Potentially applicable
	Thermal Treatment	Thermal Desorption	Volatilize organics with secondary treatment	Eliminated: High cost
		Vitrification	Fusion of solids materials into a glass-like product	Eliminated: Proven effectiveness, schedule restrictions, and high cost
Storage Disposal	Onsite Storage	Existing	Onsite storage at existing permitted facility	Potentially applicable
		New	Agency-approved new onsite storage facility	Potentially applicable
	Offsite Disposal	Waste Disposal Facility	Disposal at permitted offsite facility	Potentially applicable

LEGEND

xxxx — Technology eliminated from futher evaluation

PREPARED FOR

U.S. DEPARTMENT OF ENERGY

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

GOLDEN, COLORADO

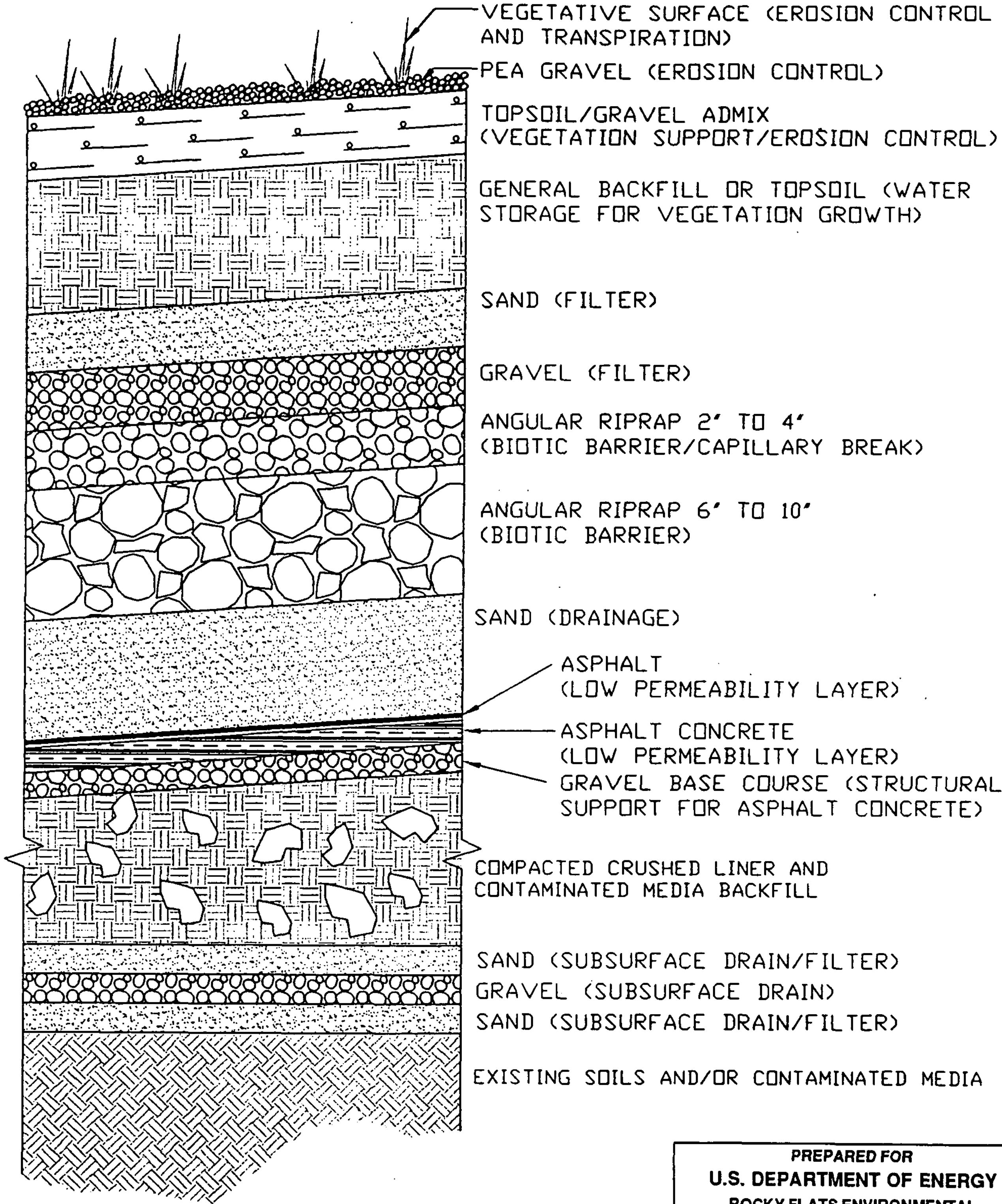
Figure ES-1

Solar Evaporation Ponds

Operable Unit No.4, IM/IRA EA DD

Initial Screening of Technologies

307IM07.pm4 pn nap 1/20/95



NOTE:

THE DEPTH OF THE GENERAL BACKFILL WILL VARY WITH RESPECT TO THE DEPTH OF THE EXCAVATION AND DESIRED FINAL GRADE.

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Figure ES-2

Solar Evaporation Ponds
Operable Unit No. 4, IM/IRA EA DD
Final Engineered Cover

Table ES-1
General Response Action Evaluation Summary
Risk Discussion

Alternative	Risk Discussion
GRA I: No action. Regrade and seed, sludge and pondcrete are disposed offsite, no debris generated.	Upward Exposure Pathways - Risk is expected to exceed the EPA acceptable threshold range. (This is based on preliminary risk calculations of $1.0x10^{-4}$ to $1.0x10^{-6}$) - Exposure pathway to vegetation and wildlife is not blocked Ground Water Exposure Pathways - Would not meet standards for ground water protection - Would not block ground water exposure pathway - No impact to future ground water remediation alternatives
GRA II A: Vegetative Cover. Consolidate contaminated liners, sludge, debris, pondcrete, and soils beneath a vegetative cover with a ground water control system.	Upward Exposure Pathways - Exposure pathway to humans would be blocked for the duration of the engineered cover performance design. Risk is expected to be less than $1.0x10^{-6}$ - Exposure pathway to vegetation and wildlife is not blocked. Ground Water Exposure Pathways - Would not meet standards for ground water protection - Would not block ground water exposure pathway - No impact to future ground water remediation alternatives

Table ES-1 (Continued)

Alternative	Risk Discussion
GRA II B: Temporary Cover. No excavation or treatment of liners or soils, no debris generated. Sludge and pondcrete remain in storage, install temporary cover.	Upward Exposure Pathways - Exposure pathway to humans would be blocked for the duration of the engineered cover performance design. Risk is expected to be less than 1.0×10^{-6} - Exposure pathway to vegetation is temporarily blocked - Exposure pathway to wildlife is not blocked. Ground Water Exposure Pathways - Would temporarily meet standards for ground water protection - Would temporarily block ground water exposure pathway via precipitation, but not via ground water rise - No impact to future ground water remediation alternatives
GRA II C: Engineered Cover. Consolidate liners, sludge, debris, pondcrete, and soils beneath a RCRA-compliant engineered cover with a ground water control system (Proposed Phase I remedy).	Upward Exposure Pathways - Exposure pathway to humans would be blocked for the duration of the engineered cover performance design. Risk is expected to be less than 1.0×10^{-6} - Exposure pathway to vegetation and wildlife is blocked by RCRA-compliant engineered cover Ground Water Exposure Pathways - Would meet standards for ground water protection - Would block ground water exposure pathway via precipitation (by the RCRA-compliant engineered cover) and ground water rise (by the subsurface drain) - No impact to future ground water remediation alternatives

Table ES-1 (Continued)

Alternative	Risk Discussion
GRA III A: Treat liners, sludge, and soils via *in situ* stabilization. Debris and pondcrete are consolidated beneath a RCRA-compliant engineered cover.	Upward Exposure Pathways - Exposure pathway to humans would be blocked for the duration of the RCRA-compliant engineered cover performance design. Risk is expected to be less than $1.0x10^{-6}$ - Exposure pathway to vegetation and wildlife is blocked by a RCRA-compliant engineered cover. Ground Water Exposure Pathways - Would meet standards for ground water protection - Would block ground water exposure pathway via precipitation due to the RCRA-compliant engineered cover, but would not block the pathway via a rise in ground water - Potential impact to future ground water remediation alternatives
GRA III B: Treat sludge and soils via *in situ* stabilization. Debris, pondcrete, and liners are consolidated beneath a RCRA-compliant engineered cover.	Upward Exposure Pathways - Exposure pathway to humans would be blocked for the duration of the RCRA-compliant engineered cover performance design. Risk is expected to be less than $1.0x10^{-6}$ - Exposure pathway to vegetation and wildlife is blocked by a RCRA-compliant engineered cover. Ground Water Exposure Pathways - Would meet standards for ground water protection - Would block ground water exposure pathway via precipitation due to the RCRA-compliant engineered cover, but would not block the pathway via a rise in ground water - Potential impact to future ground water remediation alternatives

Table ES-1 (Continued)

Alternative	Risk Discussion
GRA III C: Remove liners, sludge, debris, and pondcrete for offsite disposal, treat soils via *in situ* stabilization, construct RCRA-compliant engineered cover.	Upward Exposure Pathways - Exposure pathway to humans would be blocked for the duration of the RCRA-compliant engineered cover performance design. Risk is expected to be less than 1.0×10^{-6} - Exposure pathway to vegetation and wildlife is blocked by a RCRA-compliant engineered cover. Ground Water Exposure Pathways - Would meet standards for ground water protection - Would block ground water exposure pathway via precipitation by a RCRA compliant engineered cover, but would not block the pathway via a rise in ground water - Potential impact to future ground water remediation alternatives
GRA IV A: Remove liners; excavate soil; dispose liners, soils, debris, sludge, and pondcrete offsite; backfill and seed.	Upward Exposure Pathways - Contaminated materials are removed and the exposure pathway to humans to materials having risk greater than 1.0×10^{-6} is eliminated. The backfill and seed cover exposes humans to potential residual materials that were not excavated (risk less that 1.0×10^{-6}. - Pathway to vegetation and wildlife exposure to residual contamination is not blocked. Ground Water Exposure Pathways - Would meet standards for ground water protection - Would not block pathways for ground water to be exposed to residual contamination - No impact to future ground water remediation alternatives

Table ES-1 (Continued)

Alternative	Risk Discussion
GRA V A: Remove liners, debris, sludge, and pondcrete, for treatment/disposal offsite. Treat soils (*ex situ* treatment) backfill with treated soils and seed.	Upward Exposure Pathways - Contaminated materials are removed and the exposure pathway to humans is eliminated to materials having risk greater than $1.0x10^{-6}$. Backfill and seed cover exposes humans to potential residual materials that were not excavated or remained from the treatment (risk less that $1.0x10^{-6}$). - Pathway to vegetation and wildlife exposure to residual contamination is not blocked. Ground Water Exposure Pathways - Would meet standards for ground water protection - Would not block pathways for ground water to be exposed to residual contamination - No impact to future ground water remediation alternatives

Table ES-2
General Response Action Evaluation Summary
Schedule Discussion

Alternative	Schedule Discussion
GRA I: No action: Regrade and seed, sludge and pondcrete disposed offsite, no debris generated.	6 months closure construction
GRA II A: Vegetative Cover. Consolidate contaminated liners, sludge, debris, pondcrete, and soils beneath a vegetative cover with a ground water control system.	8 months closure construction
GRA II B: Temporary Cover. No excavation or treatment of liners or soils, no debris generated. Sludge and pondcrete remain in storage, install temporary cover.	10 months closure construction
GRA II C: Engineered Cover. Consolidate liners, sludge, debris, pondcrete, and soils beneath a RCRA-compliant engineered cover with a ground water control system (Proposed Phase I remedy).	29 months closure construction
GRA III A: Treat liners, sludge, and soils via *in situ* stabilization. Debris and pondcrete are consolidated beneath a RCRA-compliant engineered cover.	24 months closure construction
GRA III B: Treat sludge and soils via *in situ* stabilization. Debris, pondcrete, and liners are consolidated beneath a RCRA-compliant engineered cover.	24 months closure construction
GRA III C: Remove liners, sludge, debris, and pondcrete for offsite disposal, treat soils via *in situ* stabilization, construct RCRA-compliant engineered cover.	29 months closure construction
GRA IV A: Remove liners, excavate soil, dispose liners, soils, debris, sludge, and pondcrete, offsite, backfill and seed.	20 months closure construction
GRA V A: Remove liners, debris, sludge, and pondcrete, for treatment/disposal offsite. Treat soils (*ex situ* treatment) backfill with treated soils and seed.	20 months closure construction

Table ES-3
General Response Action Evaluation Summary
Cost Discussion

Alternative	Cost Discussion
GRA I: No action. Regrade and seed, sludge and pondcrete remain in storage, no debris generated. (Second cost represents regrading and seeding the SEPs with the treatment and disposal of pondcrete and sludge.)	\$15,000,000 \$156,000,000
GRA II A: Vegetative Cover. Consolidate contaminated liners, sludge, debris, pondcrete, and soils beneath a vegetative cover with a ground water control system.	\$74,000,000
GRA II B: Temporary Cover. No excavation or treatment of liners or soils, no debris generated. Sludge and pondcrete remain in storage, install temporary cover.	\$21,000,000
GRA II C: Engineered Cover. Consolidate liners, sludge, debris, pondcrete, and soils beneath a RCRA-compliant engineered cover with a ground water control system (Proposed Phase I remedy).	\$84,000,000
GRA III A: Treat liners, sludge, and soils via *in situ* stabilization. Debris and pondcrete are consolidated beneath a RCRA-compliant engineered cover.	\$100,000,000
GRA III B: Treat sludge and soils via *in situ* stabilization. Debris, pondcrete, and liners are consolidated beneath a RCRA-compliant engineered cover.	\$101,000,000
GRA III C: Remove liners, sludge, debris, and pondcrete for offsite disposal, treat soils via *in situ* stabilization, construct RCRA-compliant engineered cover.	\$324,000,000
GRA IV A: Remove liners, excavate soil, dispose liners, soils, debris, sludge, and pondcrete, offsite, backfill and seed.	\$901,000,000

Table ES-3 (Continued)

Alternative	Cost Discussion
<u>GRA V A:</u> Remove liners, debris, sludge, and pondcrete, for treatment/disposal offsite. Treat soils (*ex situ* treatment) backfill with treated soils and seed.	$537,000,000

PART I

INTRODUCTION

I.0 INTRODUCTION

This Decision Document was prepared to request community input and Colorado Department of Public Health and the Environment (CDPHE) and U.S. Environmental Protection Agency (EPA) Region VIII approval to close and remediate Operable Unit 4 (OU4) at the U.S. Department of Energy's (DOE's) Rocky Flats Environmental Technology Site (RFETS) in Jefferson County, Colorado. The Decision Document has been prepared to fulfill the DOE's obligations under the RFETS Interagency Agreement (IAG) and to provide an expedited Resource Conservation and Recovery Act (RCRA) closure action for the OU4 Solar Evaporation Ponds (SEPs). The SEPs are identified as Individual Hazardous Substance Site (IHSS) Number 101. As required by the IAG, the closure action must be consistent with the guidance provided in Volume 55 of the *Federal Register* (page 8704) for implementing interim actions, and with the Colorado Hazardous Waste Act (CHWA) interim status closure requirements and post-closure care requirements for hazardous waste surface impoundments. This Decision Document is a RCRA Class III permit modification submitted by the DOE to request CDPHE and EPA approval for all of the activities recommended for the Interim Measure/Interim Remedial Action (IM/IRA). Under the terms of the IAG, the CDPHE is the lead regulatory agency for OU4.

The IAG specifies a two-phase program for the closure/remediation of the SEPs. The Phase I program is implemented to provide a RCRA closure action for the SEPs. The phase II RFI/RI will be conducted under a separate project to determine the risk associated with the contamination at OU4, and to assess the need for ground water remediation (Phase II). The final Comprehensive Environmental Response, Compensation, and Liabilities Act (CERCLA) Record of Decision (ROD) and the concurrent RCRA Corrective Action Decision (CAD) for the SEP remediation/corrective action will be issued at the conclusion of the Phase II program.

OU4 includes five Solar Evaporation Ponds, which starting in the late 1950s were used to store and evaporate radioactive process water. In the early 1980s DOE, began phasing out the use of the solar evaporation ponds. The DOE's intent was to drain and treat the liquid waste and process the pond sludge. Cleanup activities began in 1985 to drain and remove the sludges from the five Solar Evaporation Ponds [207-A, 207-B series (north, center, and south), and 207-C] and the Building 788 Clarifier. The intent was to process the sludges to produce pondcrete blocks. Portland cement, flyash, bentonite and/or drying agents (e.g. calcium, chloride, and silica gel) were common mixing agents with the pond sludge. Approximately 2000 pondcrete blocks had been produced, shipped, and buried at the Nevada Test Site (NTS) by September 1986.

The sludges were originally classified as a low-level radioactive waste until September of 1986 when relatively low concentrations of hazardous constituents were detected, thus resulting in the reclassification of the pondcrete blocks to a mixed waste. (Part II Appendix A contains summary tables identifying both the chemical and radiological sampling results from the solar pond (liquid and sludge), pondcrete, and clarifier.) The detection of the hazardous constituents had a significant impact on the management requirements for pondcrete as well as the disposal requirements, since at that time NTS was not permitted to dispose of mixed waste. It was determined that process operations would continue to stabilize the waste through the pondcrete block process. The final step in the pondcrete process was the pouring of the sludge cement mixture into large tri-wall fiberwall boxes with plastic liners. These blocks were then stored on open air pads for curing. However, the tri-wall fiberwall boxes did not weather well and in May of 1988 some of the boxes had started to deteriorate as did some of the pondcrete blocks.

About the same time RFP was investigating the pondcrete process, NTS inspected 28 blocks shipped from the Rocky Flats Plant that had not yet been buried. Only 3 of the 28 blocks were considered to be hard; however, NTS did accept the pondcrete blocks for burial since no free liquid was detected during the assessment. As a result of the sites' evaluations, the pondcrete processing operations were halted to re-evaluate the pondcrete solidification process. Due to the differential integrity of the stored pondcrete, segregation categories were developed, and the pondcrete containers were segregated for reprocessing and repackaging in November of 1989 (GAO, 1991). The pondcrete block shipments to NTS ceased in 1990. Estimates currently indicate that approximately 10,000 cubic yards of pondcrete remain at the RFETS.

In 1993, sludges were collected via vacuum trucks and contained in sixty-six 10,000 gallon capacity storage tanks. This action was conducted to comply with the CDPHE's mandate as well as supporting the Phase I RFI/RI characterization activities. These tanks are currently stored on the 750 Storage Pad.

Based on characterization results and the chosen remedial alternative, the potential exists for the remediation of IHSS 176, the S&W Contractor Storage Yard (including Building 964) and Building 788 with it's associated ancillary equipment under the OU4 closure activities. The S&W contractor storage yard, IHSS 176, has been in operation since 1970 but was not intended as a storage facility for hazardous waste. The yard was used for the storage of surplus or raw materials from construction or maintenance projects. However, general waste containers have been stored in numerous areas throughout the yard. In 1985, materials at various locations throughout the yard were identified as hazardous waste. These hazardous waste containers were removed and dispositioned in accordance with plant operating procedures. Characterized results presented in Part II of this IM/IRA-EA Decision Document indicate that the IHSS 176 soils were contaminated due to the operation of the OU4 SEPs. Therefore, OU4 has annexed IHSS 176.

This IM/IRA Environmental Assessment (EA) Decision Document includes the results of the RCRA Facility Investigation/Remedial Investigation (RFI/RI) and closure actions proposed for the OU4 SEPs and RCRA Units 21, 48 (Building 788 and ancillaries), and 24 (Building 964). The closure of RCRA Units 21, 24, and 48 will be certified separately from the closure of the SEPs. The closure of RCRA Units 21, 24, and 48 is administratively included in this IM/IRA because the units require removal for implementation of the SEP closure. The IM/IRA program addresses the closure of the SEP sources and soils, specifically the SEP structures, sludges, pondcrete, liners, utilities, Building 964, Building 788 and its ancillaries, and contaminated surficial and vadose zone soils within the designated boundaries of OU4 (including a portion of IHSS 176). In accordance with the IAG Scope of Work, the IM/IRA is to address all hazardous substance source areas with health-based cumulative carcinogenic risk levels greater than 1.0×10^{-6} evaluated at the source, and requires cleanup of all such source areas. The 1.0×10^{-6} risk level is defined as a one-in-one-million probability of an individual developing cancer over a lifetime as a result of exposure to all of the OU4 carcinogenic contaminants in excess of the chance of contracting cancer from background sources. The OU4 IM/IRA also addresses the risk from noncarcinogenic contaminants.

A baseline risk assessment was not conducted for the IM/IRA because closure of the SEPs will change the baseline conditions to be assessed. While the risk analysis conducted as part of the OU4 IM/IRA is not a complete baseline risk assessment (based on the relative certainty that an IM/IRA would alter the baseline risk), a concerted effort was made to ensure that all of the assumptions used in the risk analysis were as conservative as those used in a baseline risk assessment. The analysis of the potential risks focused on the impacts to human health from direct contact, inhalation, and incidental ingestion of media contaminated with carcinogenic and non-carcinogenic constituents. Impacts to receiving media were also considered. The IM/IRA program was designed within the IAG to minimize risks to human health and the environment posed by OU4 sources and soil contamination by eliminating potential exposure pathways and preventing migration of the contaminants to ground water and surface water. Areas within OU4 that are located between the Perimeter Security Zone fences or are under or adjacent to active facilities (defined in Section I.2) will not be remediated under this IM/IRA. These areas will be transferred to an Operable Unit within the Industrial Area or to the informally proposed Comprehensive Industrial Area Operable Unit. The evaluation of potential risks to human health and the environment from the ground water pathway and from ground water remediation are not specific components of this IM/IRA (as directed in the IAG). Soils that are impacted by contaminated ground water that seeps to the surface along the northern hillside of the SEPs area to the security fence will not be remediated as part of the OU4 IM/IRA. These areas will be remediated (as required) upon completion of the subsequent hydrogeologic studies.

The potential impacts to the ground water system will be evaluated separately through the Phase II RFI/RI. These investigations will consist of hydrogeologic studies and a focused baseline risk assessment to assess the nature and potential extent of the contamination and the potential release of contaminants into the ground water system. In addition, the Phase II RFI/RI will evaluate both the present and future risks to human health and the environment associated with the ground water, surface water, and airborne exposure pathways (baseline risk assessment). The hydrogeologic characterization data and risk assessment results will be used to determine if additional actions are required to remediate past OU4 contaminant releases into the ground water. If additional actions are required, a detailed analysis of the various remedial alternatives will be conducted via a separate project to select and design a remedy for the ground water exposure pathway.

This document is organized into five parts. Part I provides general information regarding the purpose of an IM/IRA decision document, background information about the RFETS and the SEPs, and the specific scope of this IM/IRA effort. The DOE collected a limited number of environmental samples from the vicinity of the OU4 SEPs in 1986, 1987, and 1989, and then developed an RFI/RI work plan for a comprehensive sampling and analysis program based on the results of the historical monitoring to investigate sources and soils. The RFI/RI sampling and analysis were conducted in 1993; the results are presented in Part II along with an assessment of the validity and usability of the historical data. Part II also provides analytical data for IHSS 176, which has been annexed by OU4. Some appropriate historical data and the Phase I RFI/RI data are used in Part III to conservatively determine the contaminants of concern and the risk-based preliminary remediation goals for soils, and to evaluate potential general closure/remediation response actions. The development and evaluation of potential remediation technologies and General Response Actions (GRAs) are provided in Part III. Part IV provides a description of the recommended GRA alternative and the conceptual design of the IM/IRA. Monitoring and maintenance activities that will be conducted to assess the performance of the IM/IRA and to comply with the RCRA/CHWA post-closure care requirements are described in Part V.

I.1 INTERIM MEASURE/INTERIM REMEDIAL ACTION OBJECTIVE AND PURPOSE

The purpose of the OU4 IM/IRA program is to close the SEPs and remediate the contaminated soils without adverse impact to human health and the environment. The general programmatic objectives of the IM/IRA are:

- To characterize the nature and extent of surface and vadose zone soil contamination and to characterize contaminant sources (e.g., SEP liners, sludges, pondcrete, and components);
- To assess the potential human health and environmental risks resulting from unmitigated exposure to contaminants found in soils and/or air which present a cumulative carcinogenic risk greater than 1.0×10^{-6};
- To determine the need to prevent, eliminate, or mitigate potential exposure to human and environmental receptors from soil contaminants, airborne contaminants, and contaminated surface water runoff;
- To be consistent with the final long-term remedy for OU4 and, to the extent practicable, to be consistent with the expected requirements for ground water protection;
- To be in accord with Paragraphs 15, 150, and Attachment 2, Section I.B.10 of the IAG, which requires that the IM/IRA be consistent with the guidance provided in Volume 55 of the *Federal Register,* page 8704, for implementing

interim actions and to comply with the CHWA interim status closure requirements and post-closure care requirements for hazardous waste surface impoundments;

- To comply with the CDPHE and EPA approved Applicable or Relevant and Appropriate Requirements (ARARs) as specified in the IAG. The IM/IRA will comply with the required portions of RCRA; the Comprehensive Environmental, Response, Compensation, and Liability Act (CERCLA); and the National Environmental Policy Act (NEPA);

- To be designed and implemented within the schedule milestones specified in the IAG;

- To minimize the generation of new waste requiring treatment, storage, and/or disposal;

- To be acceptable to the community and approved by the regulatory agencies;

- To include implementation provisions that will eliminate or minimize the potential spread of contaminants as a result of implementing the IM/IRA; and

- To be implemented within the congressionally accepted fiscal constraints.

In accordance with the IAG, DOE conducted the OU4 RFI/RI to select an IM/IRA for the closure of the SEPs as a Phase I remediation activity. The subsequent hydrogeologic investigations and potential ground water remediation will be conducted separately as Phase II activities.

I.2 SITE HISTORY AND OPERABLE UNIT 4 BACKGROUND

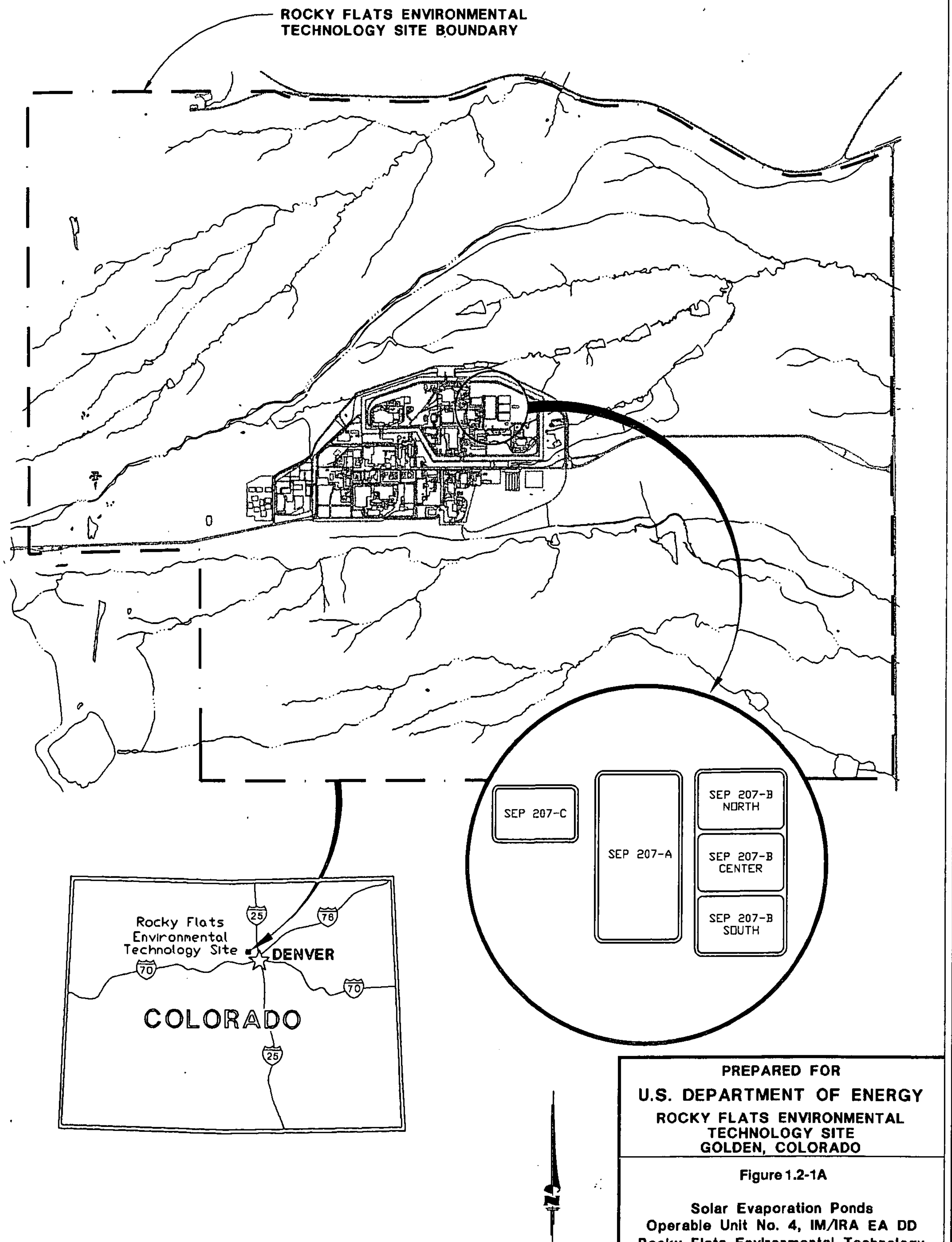
RFETS is a government-owned, contractor-operated facility formerly used for the fabrication of special nuclear materials for national defense. The 6,550-acre site is located in northern Jefferson County, Colorado, approximately 16 miles northwest of Denver. The cities of Boulder, Broomfield, Westminster, Golden, and Arvada are located less than 10 miles to the northwest, northeast, east, south, and southeast, respectively. Figure I.2-1A shows the location of the RFETS in relation to the State of Colorado. Figure I.2-1B shows the location of the RFETS in relation to Denver, Colorado.

Centrally situated within the RFETS boundary is a 400-acre security area that contains the buildings and other structures formerly used to support the weapon component fabrication operations. The remaining 6,150 acres consist of undeveloped land used as a buffer zone to further limit access to the operations area. OU4 is within a high-security Protected Area (PA) within the general RFETS security area. Fabrication operations began at the RFETS in 1951 and ceased in 1991 when the RFETS was placed into a shut-down condition. The operations resulted in the generation of liquid and solid wastes containing radioactive and hazardous constituents that were managed in various waste processing units.

These waste processing units included the SEPs located in the northeastern portion of the 400-acre security area. The SEPs consist of five current surface impoundments designated as SEPs 207-A, 207-B North, 207-B Center, 207-B South, and 207-C, as well as three original surface impoundment cells. Figure I.2-2 shows the locations and relative dimensions of the current SEPs (DOE, 1988). Section I.2.1.1 provides a discussion of and locations for the original SEPs.

From 1953 to 1986, the SEPs were operated primarily to store and evaporate radioactive process wastes and neutralized acidic process wastes containing high levels of nitrate and aluminum hydroxide. Placement of process wastewater into these ponds ceased in 1986 due to changes in the RFETS waste treatment operations. The SEPs were used to manage liquid process wastes having less than 100,000 picocuries per liter (pCi/l) of total long-lived alpha activity (DOE, 1980). Characterization results from the fall of 1958 (Ryan, 1958) indicate that the average potential of hydrogen (pH) of the waste in SEP 207-A was 0.93 pH units, indicating that the wastewaters were very acidic.

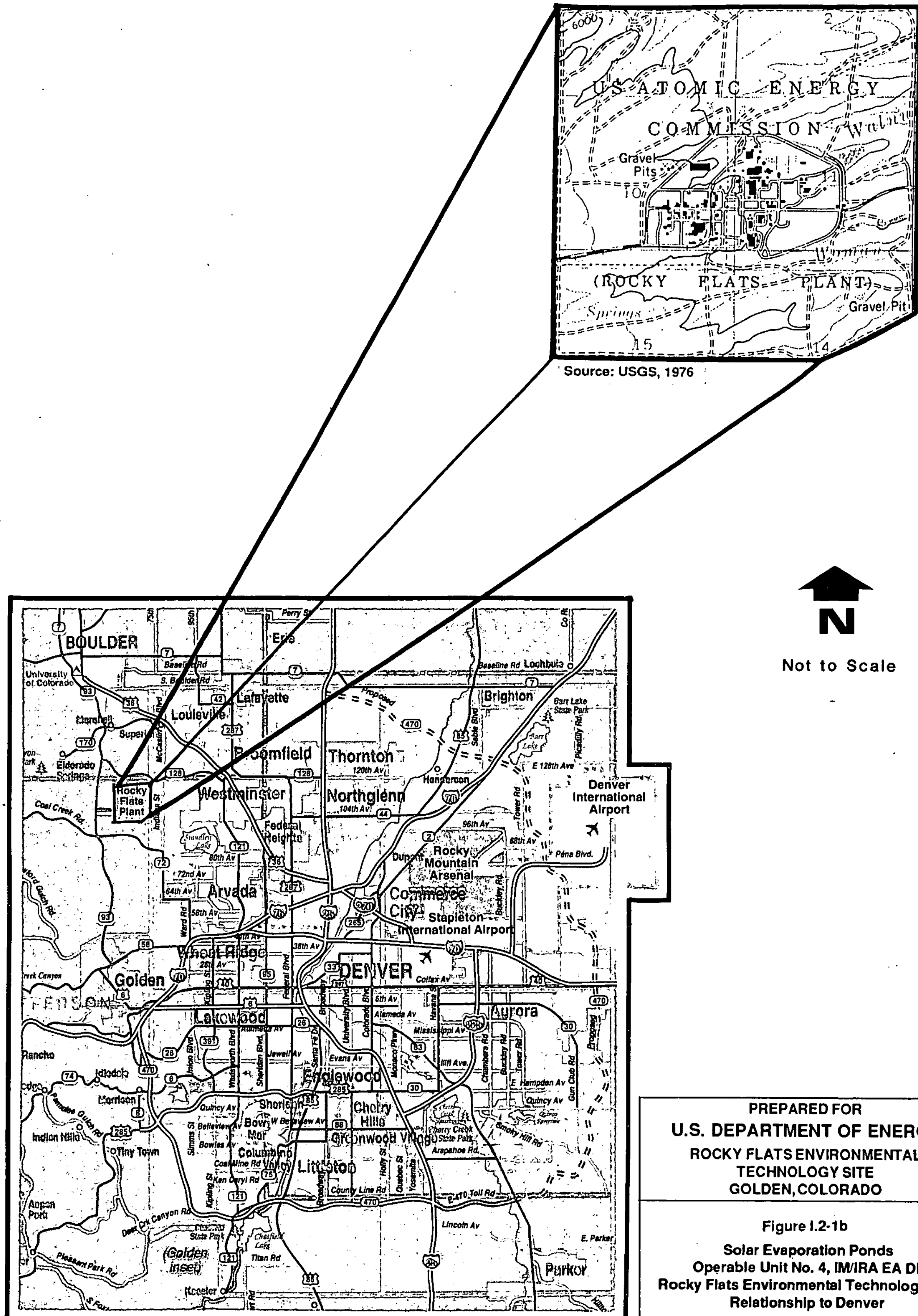
Removal of SEP 207-A sludge began on June 19, 1985. Sludge removal and processing equipment was installed to support the operations and maintenance of the SEPs. In 1986, sludge from the SEP 207-A was mixed with Portland cement to form "pondcrete." In 1985, Building 788 was constructed between SEPs 207-C and 207-A as a storage facility for the pondcrete waste containers. In 1988, an addition was made to the northern end of Building 788. This addition was constructed to increase the pondcrete storage capacity.



PREPARED FOR
U.S. DEPARTMENT OF ENERGY
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Figure 1.2-1A

Solar Evaporation Ponds
Operable Unit No. 4, IM/IRA EA DD
Rocky Flats Environmental Technology Site Location Map



PREPARED FOR

U.S. DEPARTMENT OF ENERGY

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Figure I.2-1b

Solar Evaporation Ponds
Operable Unit No. 4, IM/IRA EA DD
Rocky Flats Environmental Technology Site
Relationship to Denver

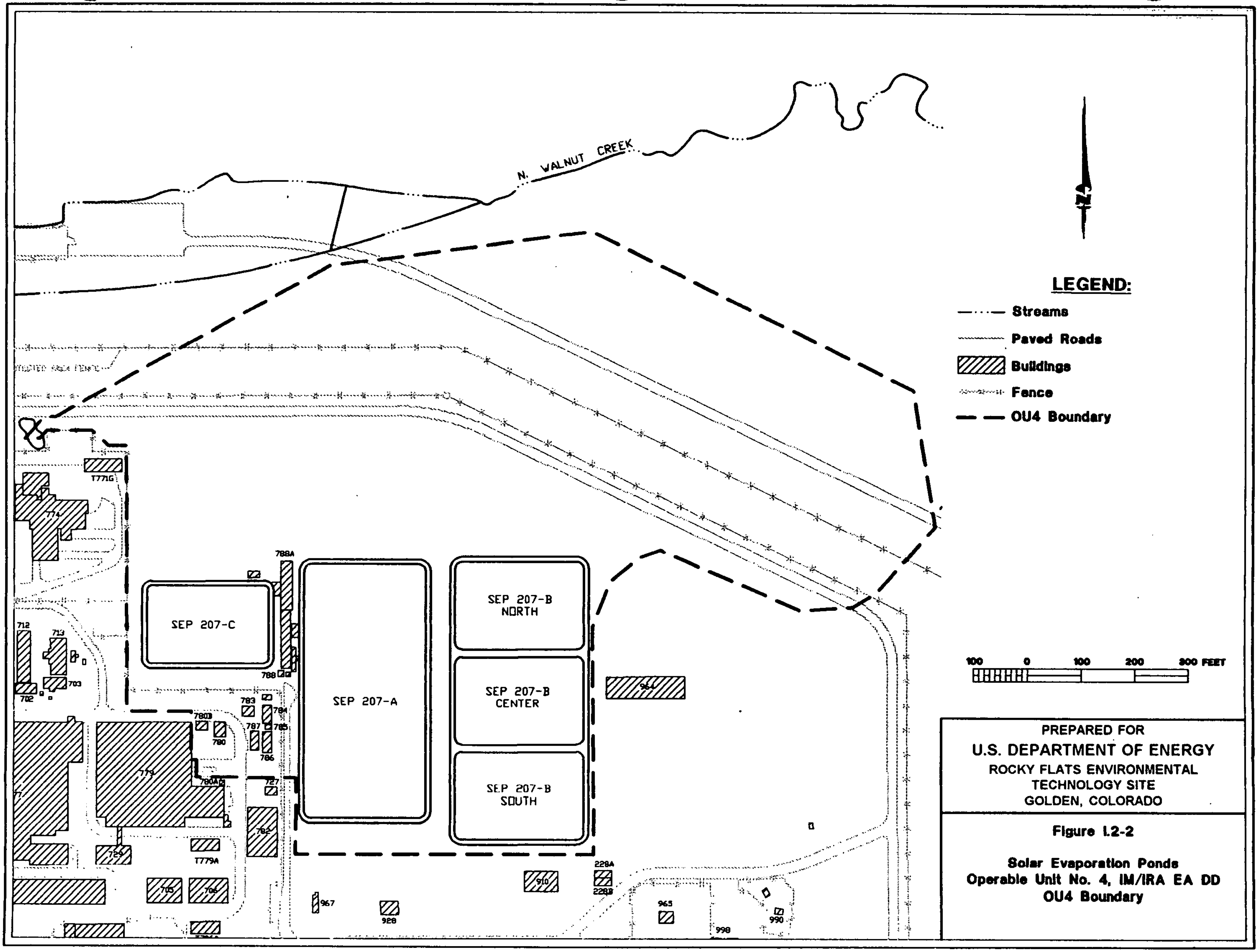


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Figure I.2-2

Solar Evaporation Ponds
Operable Unit No. 4, IM/IRA EA DD
OU4 Boundary

The materials placed into the SEPs include:

- Radioactively contaminated aluminum scrap;
- Alcohol wash solutions;
- Drums of waste radiography solutions;
- Leachate from the RFETS sanitary landfill;
- Treated sanitary effluent;
- Ground water intercepted from the Interceptor Trench System (ITS);
- Saltwater solutions;
- Wash waters from the decontamination of production personnel;
- Cyanide wastes;
- Acid wastes; and
- Other compounds such as sodium, cadmium, nitrate, ferric chloride, lithium chloride, sulfuric acid, ammonium persulfate, hydrochloric acid, nitric acid, and hexavalent chromium.

In addition to the above chemicals and compounds, it is reported that lithium scrap was reacted with water adjacent to the SEPs, and the solution was transferred to the SEPs. Based on these historical records, both characteristic (D006) and listed (F001, F002, F003, F005, F006, F007, and F009) wastes were placed into the SEPs (EG&G, 1992a).

The chronological construction and operation details for the SEPs (including information on potential releases, leakage monitoring, pond repairs, and cleanup activities) are presented in Appendix I.A and summarized below. *[Note: Refer to Appendix I.A for additional details and source citations.]* The chronological summary is divided into Section I.2.1, which discusses the construction and operation of the SEPs, and Section I.2.2, which provides information regarding the remediation and closure activities. Additional historical information and pond construction drawings are provided in the *Closure Plan: Solar Evaporation Ponds* (DOE, 1988).

I.2.1 Solar Evaporation Pond Construction and Operation

This section provides construction and operation information for each of the SEPs. Table I.2-1 summarizes this information.

I.2.1.1 Original Solar Evaporation Ponds

The original SEP, also known as Pond 2, was constructed in October 1953 on the existing grade; it measured approximately 200 feet by 200 feet by 6 feet. A clay dike was constructed around the perimeter, and the base of the pond was clay-lined. The operation of Pond 2 commenced in December 1953. Seeps were subsequently discovered along the northern, southern, and eastern dikes. Additional clay was added to the dikes as needed to repair the seeps.

TABLE I.2-1
SOLAR EVAPORATION POND DESIGNATIONS AND STATUS

Current Designation	Original Designation	Date Completed	Current Status
Original Clay-Lined Solar Evaporation Pond	Pond 2	October 1953	Regraded in 1970, soils from pond possibly incorporated into berms for 207-C
Not Applicable[a]	Pond 2 Auxiliary[b]	September 1955	Regraded in 1962 for construction of Building 779
Not Applicable[a]	Pond 2D	April 1959	Regraded in 1970, soils from pond possibly incorporated into berms for 207-C
Solar Evaporation Pond 207-A	Pond 2A	August 1956	Process waste and water removal activities were completed in 1988. SEP 207-A is currently dry.
Solar Evaporation Pond 207-B (consists of three cells: North, Center, and South)	Solar Evaporation Pond 2B (consists of three cells: North, Center, and South)	June 1960	SEPs 207-B Center and North emptied in early 1993. Process waste was removed from SEP 207-B South in late 1993.
Solar Evaporation Pond 207-C	Solar Evaporation Pond 207-C	December 1970	Process waste removal was completed in January 1995.

[a]This pond could be confused with the original clay-lined solar evaporation pond since it was of earthen construction only.

[b]This pond was also known as Solar Evaporation Pond 2C. It was originally unlined, but was provided with a clay liner in January 1957.

Source: DOE, 1992g.

In September 1955, a second earthen pond, designated as Pond 2-Auxiliary, measuring 100 feet by 200 feet by 6 feet, was constructed to the southeast of Pond 2 to maintain operational capacity while plans for a new watertight pond were being finalized. *[NOTE: Pond 2-Auxiliary is referred to as Pond 2C in some documents.]* A weir was installed in the southeastern corner of Pond 2 to allow waste to overflow into Pond 2-Auxiliary. The new pond was unlined and leaks were observed along the eastern boundary within the first month of operation.

In August 1956, Ponds 2 and 2-Auxiliary were removed from service upon completion of the new watertight SEP (SEP 207-A). These ponds were allowed to dry so that a clay liner could be installed. Completion of the clay liner installation for Pond 2-Auxiliary and Pond 2 occurred in February and March 1957, respectively. The re-lined ponds were then returned to regular service.

A third clay-lined pond, Pond 2D, was constructed in April 1959 to contain any overflow from SEP 207-A and to support denitrification experiments. This third pond was located immediately east of Pond 2 as shown on Figure I.2-3. In December of 1959, drainage tile was installed east of Pond 207-A.

Routine use of Ponds 2, 2-Auxiliary, and 2D ceased in June 1960 when the B-Series SEPs were placed into service. The only other known discharge to these SEPs after June 1960 occurred in March 1963.

During April of 1961, drainage tile was constructed east of the 207-B Ponds. In July of 1961, construction activities were implemented to reline the drainage tile associated with 207-B center and 207-b north.

In October 1962, the Pond 2-Auxiliary area was regraded for the construction of Building 779. The clay lining and contaminated soils were removed and placed in one of the East Trenches at the RFETS. Soil samples collected from the bottom of Pond 2-Auxiliary showed activities of between 11,000 to 75,000 disintegrations per minute per kilogram (dpm/kg).

The Pond 2 and Pond 2D areas were regraded in 1970 to accommodate construction of SEP 207-C. The soils and dikes from these ponds may have been used in the construction of SEP 207-C. The approximate locations of the original solar evaporation ponds with respect to the existing SEPs are shown on Figure I.2-3.

I.2.1.2 SEP 207-A

SEP 207-A was placed in service in August 1956 to provide additional storage capacity. This pond was originally constructed with a liner consisting of asphalt planks approximately 0.5-inch thick, 3 feet wide, and 14 feet long. The pond measured approximately 250 by 525 feet at the crest with side slopes of 1:2. The maximum operating depth was approximately 7.5 feet, resulting in an impoundment volume of approximately 5 million gallons (DOE, 1988).

This pond operated with a minimum freeboard of 2 feet. In September 1958, aluminum paint was applied to the exposed surface of SEP 207-A to increase evaporation.

In December 1959, drainage tile was installed along the eastern edge of SEP 207-A to intercept seeps discovered during the excavation of the 207-B SEPs. A sump and pump system was installed in April 1970 to return the collected water to SEP 207-A.

In November 1963, modifications were completed to correct problems associated with the liner cracking and slumping which resulted in leakage of the pond contents. These modifications included replacing the asphalt planking with an asphalt concrete liner, changing the side slopes to 1:3.7, and regrading the base of the pond to drain to a sump at the northeastern end of the pond. The asphalt concrete liner consists of a 4-inch-thick aggregate base placed on top of the subgrade, overlain by an asphalt prime coat, 1.5 inches of asphalt concrete, an asphalt tack coat, 1.5 inches of asphalt concrete, and a catalytically-blown asphalt seal coat. Engineering drawings showing construction and liner details are presented in the *Closure Plan: Solar Evaporation Ponds* (DOE, 1988).

In April 1964, a pump was installed at SEP 207-A to facilitate liquid transfer among the SEPs (Ryan, 1964). In 1986, routine placement of waste in SEP 207-A ceased, and dewatering and sludge removal was initiated. Portland cement was mixed with the removed sludge to form pondcrete for offsite disposal (see Section I.2.2.2). The last of the process water and sludge was removed from this SEP in July 1988.

To minimize the potential leakage of ground water to the underlying soils, the asphalt concrete side slopes of SEP 207-A were relined with a 1/8-inch-(minimum) thick, rubberized, crack-sealing material in the fall of 1988.

In July 1988, the final process waters and sludges were removed from SEP 207-A. From 1988 to 1992, a limited amount of precipitation and sediment collected in the SEP. In March 1990, approximately 1.3 million gallons of water were transferred from the 207-B SEPs to SEP 207-A to prevent the overflow of liquids. The transferred water was removed in the fall of 1992 prior to the commencement of the RFI/RI drilling program in December 1992.

I.2.1.3 SEPs 207-B North, Center, and South

The 207-B Series SEPs (North, Center, and South) were placed in service in June 1960. These ponds were originally lined with asphalt planking approximately 0.5-inch thick, 3 feet wide, and 14 feet long. Each pond measures approximately 180 by 253 feet. The maximum operating depth for SEP 207-B South was 5.5 feet and 6.5 feet for SEPs 207-B Center and North, resulting in an impoundment volume of approximately 1.5 million gallons each.

In June 1960, the transfer of waste from SEP 207-A to SEPs 207-B South and Center was initiated. These transferred wastes were acidic and produced gases which lifted the asphalt planking, thus rupturing the liner seams and resulting in leakage from the SEPs. Because of these problems, transfer operations were halted and the waste was returned to SEP 207-A. To return the waste to SEP 207-A, the waste had to be transferred to SEP 207-B North, which resulted in damage to all three of the 207-B Series SEPs. The asphalt planking within SEP 207-B South was covered with asphalt concrete in November 1960. The first six ground water monitoring wells were installed in the vicinity of the 207-B Series SEPs in November 1960. Repair of SEPs 207-B Center and North was deferred because of funding limitations. SEP 207-B South was returned to service in December 1960.

In April 1961, repairs to the 207-B Series SEPs included installation of a drainage trench along their eastern edge. A sump and pump system was later installed in April 1970 to return the collected water to SEP 207-B North. SEPs 207-B Center and North were relined with asphalt concrete in July 1961. Because of difficulty in laying the asphalt concrete over the asphalt planking, the planking was removed from SEP 207-B North prior to it being relined with asphalt concrete. The two relined SEPs were then returned to service.

The placement of process waste into the 207-B Series SEPs ceased around 1974. A SEP clean-out program was initiated in 1974 and extended until 1977, when all process wastes were removed. Since 1977, the SEPs were used to hold treated sanitary effluent, treated water, and brine from the Reverse Osmosis Facility in addition to contaminated ground water from the ITS. The B-Series SEPs were also used to contain the treated wastewater generated during the June-July 1993 hot systems operations testing of the Building 910 evaporators.

In April 1967, an unsuccessful attempt was made to fill the cracks on the side walls of SEP 207-B North with asphalt mastic. In November 1967, side wall cracks in SEP 207-B North were successfully repaired with burlap and asphalt. In October 1968, the side walls of SEP 207-B Center were successfully repaired with burlap and asphalt covering, and an additional coat of asphalt was applied to SEP 207-B North. Additional coats of burlap and asphalt were applied to SEPs 207-B North and 207-B Center in September 1969 and October 1969, respectively. The side walls of SEP 207-B South were covered with burlap and asphalt in September 1970. The side walls of SEPs 207-B North and Center were covered with Petromat® and hydraulic sealant in October 1971. The side walls and bottoms of SEPs 207-B South and 207-B North were relined with Petromat® and hydraulic sealant in October 1972 and September 1973, respectively.

In 1978, the Petromat® liners of SEPs 207-B Center and South were removed, bagged, and cemented for offsite disposal. The asphalt concrete liners were not removed. SEPs 207-B Center and South were then relined with a hydraulic sealant. In addition to the sealant, a synthetic 45-mil Hypalon® liner was installed in SEP 207-B South. A leak detection system was installed between the Hypalon® liner and the asphalt concrete liner. The leak detection sump is located in the northwestern portion of the SEP, and a pipe extends from the sump to the SEP berm. The lining of SEP 207-B North was not replaced because it held only a minimal amount of sludge, and its residual radioactivity levels were low. Engineering drawings showing the construction and liner details are presented in the *Closure Plan: Solar Evaporation Ponds* (DOE, 1988).

In April 1982, water was removed from SEPs 207-B Center and North for application to the West Spray Field. At the time of the spray field operations, SEP 207-B Center contained treated sanitary effluent and SEP 207-B North contained ITS water. The spray field operations ended in November 1985.

I.2.1.4 SEP 207-C

SEP 207-C was put into service in December 1970 to provide additional process waste storage capacity and to provide interim storage for liquid from the other ponds during pond maintenance and repair work. SEP 207-C was constructed in approximately the same location as the original SEPs. This pond measures approximately 160 by 250 feet and has a maximum operating depth of 7 feet. The pond has an impoundment waste volume of 1.2 million gallons.

Based on previous experience, an asphalt concrete liner was originally installed in SEP 207-C. The liner consisted of a 4-inch aggregate base course, overlain by an asphalt prime coat, 1.5 inches of asphalt concrete, a second asphalt tack coat, 1.5 inches of asphalt concrete, an asphalt tack coat, and a surface of catalytically-blown asphalt seal coat. SEP 207-C has not been relined since its construction.

The bottom of the SEP slopes to the northeast. Design drawings indicate that a leak detection system may have been installed sometime in the late 1980s. The drawings depict the leak detection system as consisting of a perforated pipe aligned on a north-south axis under the center of the pond with the pipe terminating in a sump at the northern end. Engineering drawings showing the construction and liner details are presented in the *Closure Plan: Solar Evaporation Ponds* (DOE, 1988). SEP 207-C has not received process wastes since 1986.

I.2.2 Previous Remediation and Closure Activities

The SEPs are RCRA interim status hazardous waste management units that are currently being closed and remediated under the terms of the IAG. The operation of the SEPs has resulted in potential contamination of the surrounding soil and ground water. Various remediation and closure activities have been conducted over the years to mitigate releases from the SEPs. Major activities have included pond relining and repairs, construction of interceptor trenches, and waste removal (e.g., excess liquids and sludges); these activities are summarized in this section.

I.2.2.1 Interceptor Trench System

Throughout the history of the SEPs, ground water seeps were located downgradient from the ponds on the northern hillside. A series of trenches has been constructed adjacent to and north of the SEPs to control migration of contaminants from these seeps. This system collects surface water runoff and ground water seepage so that human health and the environment are not adversely affected. A detailed history of the trenches is presented in Appendix I.A.

In early 1970, nitrate contamination was reported along North Walnut Creek. Between 1971 and 1974, a series of six trenches and sumps were constructed north of the SEPs to prevent natural seepage and pond leakage from entering North Walnut Creek. The trenches were situated in areas of known nitrate-impacted vegetation to collect and recirculate water to the SEPs. The trench locations are shown on Figure I.2-4. Trenches 1 and 2 were installed in October 1971, Trench 3 in September 1972, Trenches 4 and 5 in April 1974, and Trench 6 in June 1974. The collected waters were transferred to either SEP 207-A or SEP 207-B North. The trenches were successful in reducing the nitrate levels in North Walnut Creek.

The original six trenches operated until construction of the Interceptor Trench System (ITS) in April 1981. The original six trenches and two sumps were not incorporated into the ITS and were abandoned in place by disconnecting their electrical power supplies (refer to Appendix I.A).

The ITS is a series of 18 french drains located on the hillside north of the SEPs that are designed to intercept the alluvial ground water (see Figure I.2-4). The depths of the drains range from approximately 1 to 27 feet below ground surface (bgs) with a typical depth of 4 to 16 feet bgs (Rockwell, 1988). The ITS was designed to be installed into the underlying bedrock; however, as-built construction drawings do not show the location of the alluvium/bedrock interface with respect to the invert elevation of the drain system. The system also includes a surface water collection trench, known as the Interceptor Trench (see Figure I.2-4). The Interceptor Trench is gravel-filled to grade to capture surface water runoff. A portion of the ITS collects drainage from the Buildings 774 and 779 footing drains.

The individual drains are connected to a common header line, and collectively allow water to drain by gravity to the interceptor trench pump house (ITPH). It is estimated that approximately 4 million gallons of water are collected in the ITS annually (DOE, 1992b). The maximum amount of water collected in any one week was 700,000 gallons in June 1987. From 1981 to 1993, the intercepted water collected in the sump at the ITPH was pumped into SEP 207-B North. Periodically, the liquid would be transferred from SEP 207-B North to SEPs 207-B Center and South. The water was pumped from the B-Series SEPs either to the portable flash evaporators in Building 910 or to the liquid waste treatment facility in Building 374. The flash evaporators and waste treatment facility augmented the solar evaporation function provided by the SEPs. Beginning in April 1993, the ITS water was diverted to the temporary Modular Tank System (TMTS) located north of the SEPs. The ITS water management changes are part of a previous IM/IRA for OU4 to allow pond cleanout operations to proceed (DOE, 1992a).

I.2.2.2 Liquid and Sludge Removal

Sludge from the SEPs has been removed occasionally to allow for maintenance and repair work on the SEP liners. In 1986, sludge was removed from SEP 207-A, mixed with Portland cement, and solidified as a mixture of sludge and cement (called pondcrete). The pondcrete was to be shipped to a radioactive waste disposal site. The first pondcrete was shipped to the Nevada Test Site (NTS) for disposal. During subsequent pondcrete operations, it was determined that the pondcrete being produced was classified as mixed waste. Shipment of the pondcrete to NTS was discontinued and the remaining pondcrete was stored onsite. All remaining liquid and sludge in the SEPs was removed in 1993 and 1994 and containerized in sixty-six 10,000 gallon capacity tanks. The stored sludge will be processed and dispositioned as a component of the IM/IRA.

In 1985, construction began on Building 788, located between SEPs 207-C and 207-A as a storage facility for the pondcrete waste containers. Construction of Building 788 was completed in October 1986. Fresh pondcrete was loaded into waste containers and placed in the southern end of Building 788 where the pondcrete cured. After curing, the containers were moved to the northern pad adjacent to Building 788. In 1988, an addition (Building 788A) was constructed on the northern end of Building 788 to increase the pondcrete storage area. In 1989, a containment structure was constructed in the northwestern end of Building 788 to accommodate the repackaging of waste containers containing pondcrete.

Building 964, located inside the Protected Area east of SEP 207-B, is a wood framed structure covered with galvanized steel siding and a rolled asphalt roof. Building 964 has a floor area of approximately 6,500 square feet. It was constructed in the late 1960's and was originally used as a tool shed. Building 964 became a waste storage facility in 1985 or 1986 when it was used to store pondcrete. Upon construction of the 750 Pad in 1987-1988, pondcrete was transferred to the pad and Building 964 was then used to store vacuum filter sludge generated in Building 374. A RCRA Part A permit application was submitted in 1986 which identified Building 964 as RCRA Unit 24. Building 964 became a permitted storage area in October 1991.

I.3. INTERIM MEASURE/INTERIM REMEDIAL ACTION SCOPE AND ASSUMPTIONS

The scope of the IM/IRA includes selecting an IM/IRA alternative for closing the five surface impoundments that comprise the SEPs; closing and removing RCRA Units 21, 24, and 48; and remediating the contaminated soils within OU4 that can be remediated without impacting operational RFETS activities.

The primary physical components of OU4 to be addressed by the IM/IRA include the sources and soils within the OU4 boundaries, such as the SEP liners and contaminated surficial and vadose zone soils. Remediation of portions of OU4 will be deferred if the remediation actions interfere with necessary RFETS activities, or if contaminated ground water would be a source of contamination to soils that were remediated under the closure activities (i.e., seep areas). If deferred, remediation will be addressed when the RFETS operations cease. In addition to these components, the IM/IRA project also will address structures that may interfere with implementing the selected GRA. RCRA Units 21, 48 (Building 788 and its ancillaries), and 24 (Building 964) will be closed/removed since they will interfere with the IM/IRA implementation. Aboveground (AG) and underground (UG) utilities and the concrete pad/foundation of Buildings 788 and 964 will be removed or relocated. In addition, the OU4 IM/IRA will include removal/remediation of specific segments of the Original Process Waste Lines (OPWLs) that may interfere with the closure/remediation of the SEPs. The OPWLs are UG utilities that transported wastes to the SEPs and transferred wastes from one SEP to another. Since the CDPHE and EPA approved the annexation of the OU9 lines (within the area of remediation) into OU4, these affected portions of the OPWLs will be transferred to OU4 to accommodate the SEP closure actions.

The OU4 project includes the disposition of the existing pondcrete that is currently stored at the RFETS. The IM/IRA project also includes the removal, treatment, or storage of liquid and sludge from SEPs 207-C and 207-B South. The removal of the pond liquid and sludge was conducted under a separately approved project. The processing and disposition of the treated liquids and sludge is a function of the IM/IRA. The scope of the IM/IRA project does not include the assessment of ground water contamination, remediation of soils contaminated by ground water, or an assessment of the ground water exposure pathway. These activities and the selection of a potential ground water remedial action, if required, will be considered at the conclusion of the Phase II RFI/RI. In addition,. the scope of the IM/IRA project does not include the existing ITS that collects ground water downgradient of the SEPs.

I.3.1 Interagency Agreement Requirements and Schedule

As required by the IAG, the IM/IRA Decision Document is a concise document that:

- States the objective of the IM/IRA (Part I),
- Discusses the interim action alternatives (Part III),
- Presents the CDPHE- and EPA-approved ARAR analysis (Part III, Section 5.2),

- Provides the rationale for selection of the preferred alternative (Part IV),
- Discusses how the selected interim remedy will be consistent with the final remedy for OU4 (Part IV, Section 11.6), and
- Complies with the deadlines specified in the IAG for implementing the IM/IRA (Part IV, Section 2.2).

This proposed IM/IRA Decision Document is submitted to CDPHE and EPA Region VIII for review and comment. The DOE will open a public comment period for a minimum of 60 days. DOE will hold a public hearing if requested by the public, CDPHE, or EPA. Public announcements will be published by DOE at least two weeks prior to the public hearing.

At the conclusion of the public comment period, DOE will prepare and submit a Responsiveness Summary and the final IM/IRA Decision Document for CDPHE and EPA review and approval. The approved final IM/IRA Decision Document will be considered the equivalent of a Record of Decision (ROD) and will meet the State of Colorado Hazardous Waste Closure Requirements. As required by the IAG, DOE will make the CDPHE- and EPA-approved IM/IRA Decision Document and Responsiveness Summary available to all interested parties at least 10 days prior to commencement of any remedial or corrective actions at OU4.

I.3.2 Assumptions

This IM/IRA Decision Document was prepared using a partially validated RFI/RI analytical data base and invalidated historical data to determine the contaminants of concern (COCs) and PRGs. As of March 1994, 87 percent of the RFI/RI data had been validated and only 1.26 percent of the total validated data had been rejected.

Portions of the historical analytical data were reviewed and the validation assessed independently of the laboratory or sample collection contractor. The purpose of the validation assessment was to determine if the historical data could be used to supplement the RFI/RI data for evaluating the nature and extent of the contamination. For the purposes of this report, historical valid and acceptable data were considered of equal utility to the RFI/RI data. Rejected data were not used in any statistical computations or contaminant source evaluation. Seventy percent of the historical data were validated as of March 1994. The rejected data represent 1.25 percent of the validated data. Part II, Section 3.6.3.1 presents information concerning the historical data validation.

The DOE, CDPHE, and EPA believe that enough validated data exist to assess and select a closure/remediation general response action. The parties believe that the final validated RFI/RI data base will not cause the COCs or PRGs to change such that the selected IM/IRA becomes inappropriate. Therefore, the conclusions within this document will not change significantly when the final data validation activities are complete. DOE will receive, validate, and evaluate the remaining data prior to implementation of the IM/IRA to ensure that the action remains appropriate.

I.4 SITE CHARACTERISTICS AND ENVIRONMENTAL SETTING

This section describes the site characteristics and environmental setting of OU4. These aspects of OU4 are important in analyzing the risks to human health and the environment as well as in designing the preferred alternative.

I.4.1 Demography and Land Use

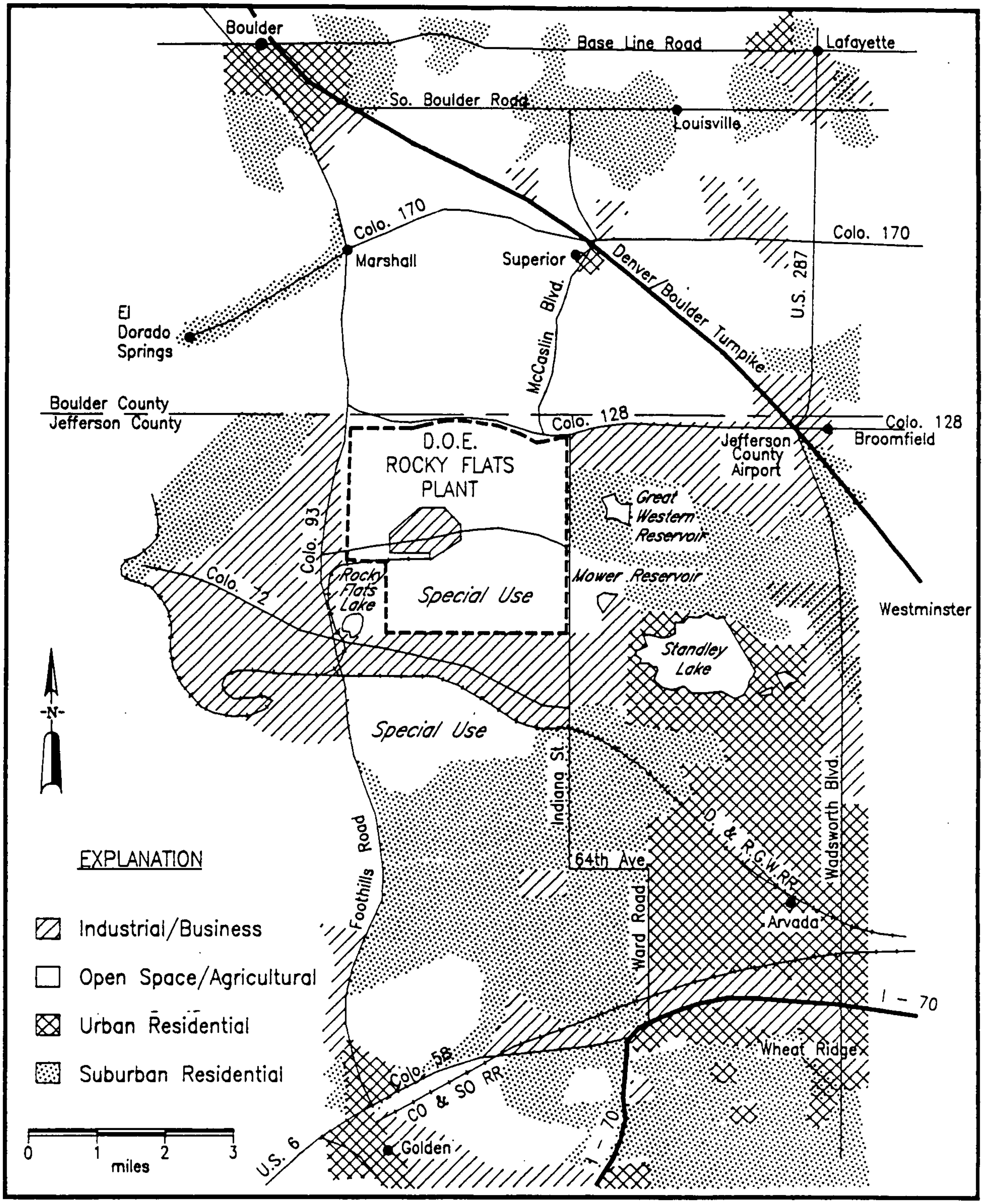
The population, economics, and land use of areas surrounding the RFETS are described in a vicinity demographics report (DOE, 1990). This report encompassed an area within a 50-mile radius from the center of the RFETS and included all or part of 14 counties and 72 incorporated cities with a combined 1989 population of 2,206,500. The largest percentage of the population is located northwest, northeast, east, southeast, and south of the RFETS (refer to Section I.4.1.1). The current RFETS population consists of approximately 7,600 workers onsite. Land use within 0 to 5 miles of the RFETS is divided into urban and suburban residential, business/industrial, and open space/agricultural. Figure I.4-1 illustrates the current land use in the vicinity of the RFETS.

I.4.1.1 Current Land Use: Residential, Business, Industrial, Agricultural, and Open Space

The area west of the RFETS is mountainous, sparsely populated, and primarily owned by the U.S. Forest Service. The area east of the RFETS is generally a high, semiarid plain, densely populated, and primarily privately owned. Most of the population included in the 1990 DOE demographics report is located within 30 miles of the RFETS, primarily in the Denver metropolitan area to the east and southeast.

The majority of residential users within 5 miles of the RFETS are located to the northwest, northeast, east, southeast, and south of the RFETS. These population areas are divided into sectors related to distance from the RFETS and representing compass direction in Figure I.4-2. The actual 1989 residential population and projected population distribution within a 5-mile radius of the RFETS for the year 2010 are presented in Figures I.4-2 and I.4-3, respectively. The current population for Sectors 1 and 2 (the RFETS and adjacent areas) is zero, and projections for population growth indicate that the region will remain sparsely populated (zero growth is anticipated for the next 17 years) (DOE, 1990). In accordance with the human health risk assessments prepared pursuant to the NEPA impact analysis, which tends to use bounding or "worst-case" exposure scenarios (DOE, 1992e), the human health impact analysis discussed in Parts III and IV of this document was based on onsite residential exposure to define the PRGs. Since Sectors 1 and 2 represent land within the RFETS boundaries, they are most relevant to the onsite residential exposure scenarios.

Most of Sector 3 and all of Sectors 4 and 5 are located outside the RFETS boundary and are therefore relevant to the offsite residential exposure scenarios. As discussed in Section I.4.1.2 (Future Land Use), these offsite regions are expected to experience significant population



(after: Jefferson County Planning and Zoning Department, April, 1990)

Source: DOE, 1991d

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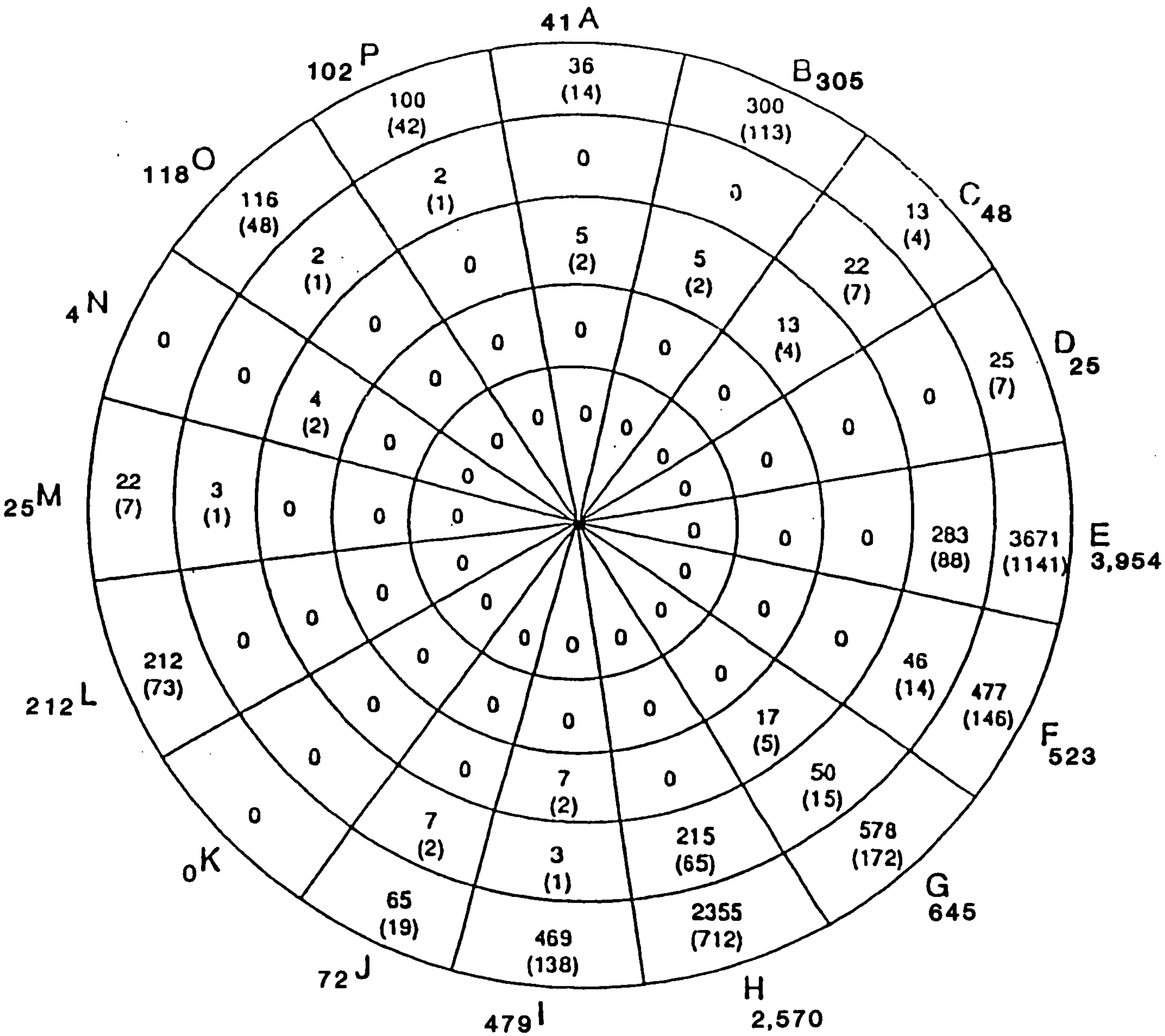
Figure I.4-1

Solar Evaporation Ponds
Operable Unit No. 4, IM/IRA EA DD
Land Use in the Vicinity of
Rocky Flats Environmental Technology Site

rf85x11



Miles from RFP Center	Sector Name	Population
0-1	Sector 1	0
1-2	Sector 2	0
2-3	Sector 3	51
3-4	Sector 4	633
4-5	Sector 5	8,439
	Total	9,123

Source: DOE. 1990. "1989 Population, Economic and Land Use Data for the RFP"

Note: The number of households is listed in parentheses for each population.

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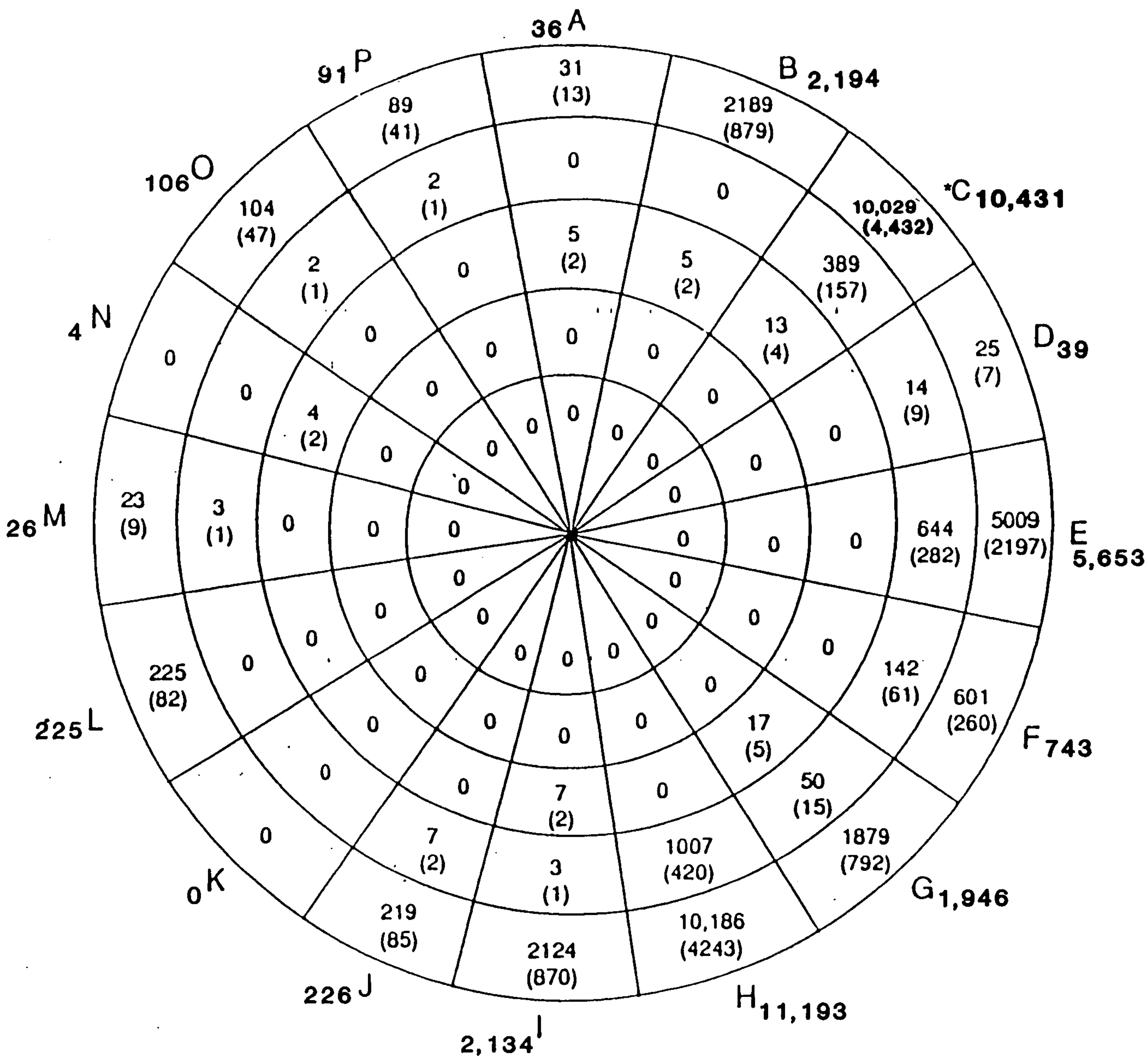
Figure I.4-2

Solar Evaporation Ponds
Operable Unit No. 4, IM/IRA EA DD
1989 Residential Populations and Households within a 5-mile Radius of the Rocky Flats Environmental Technology Site

rf85x11h



Miles from RFETS Center	Sector Name	Population
0-1	Sector 1	0
1-2	Sector 2	0
2-3	Sector 3	51
3-4	Sector 4	2,263
4-5	Sector 5	23,773
		Total 26,087

* Note: Segment C, Sector 5 - The "Population" and "Number of Households" values include the projected maximum number of occupancy permits to be issued for the Rock Creek housing development (4,000 by the year 2000)

*Source: City of Superior, 1994 DRCOG, 1994

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Figure 1.4-3

Solar Evaporation Ponds
Operable Unit No. 4, IM/IRA EA DD
Year 2010 Expected Residential Population and Households within a 5-mile Radius of the Rocky Flats Environmental Technology Site

Source: DOE. 1990. "1989 Population, Economic and Land Use Data for the RFP"

Note: The number of households is listed in parentheses for each population.

rf85x11h

increases. (See Figure I.4-3.) The total 1989 population for Sector 3 was 51. Sectors 4 and 5 contain the majority of the 1989 population (9,072) within a 5-mile radius (DOE, 1990). Segments D through I on Figure I.4-2 lie in the predominant downwind directions from OU4 and represent the primary areas potentially affected by airborne contamination from the OU4 soils. (Refer to Section I.4.3 for wind direction discussions.)

Approximately 316,000 people reside within a 10-mile radius of the RFETS. The largest residential development is located to the southeast, in the cities of Westminster, Arvada, and Wheat Ridge. The cities of Boulder to the northwest; Broomfield, Lafayette, Louisville, and Superior to the northeast; and Golden to the south also contain significant residential developments within this 10-mile radius (DOE, 1990).

Business/commercial development is concentrated near the residential developments around Standley Lake south and southeast of the RFETS, and near the Jefferson County Airport, approximately 3 miles northeast of the RFETS. Several small businesses are located to the south along State Highway 72.

Active industrial land use within 5 miles of the RFETS includes the following operations or activities: a sawmill and aggregate company to the north of the RFETS on State Highway 93; a sanitary landfill, a paving company, and a rock products company south of the RFETS on State Highway 93; and an analytical laboratory, a steel fabrication company, and a rock and dirt excavation company south of the RFETS on State Highway 72 (EG&G, 1991a). Active sand-and-gravel mines lie within the buffer zone boundaries (DOE, 1991d).

There are several inactive mining operations in the vicinity of the RFETS. Coal was mined in the region as recently as the 1950s (EG&G, 1992c). The Schwartzwalder Uranium Mine is located approximately four miles southwest of the RFETS. The mine was once the largest producer of vein-type uranium ore in Colorado and ranked among the largest of its type in the United States (DOE, 1980; DOE, 1991d). The mine was closed in 1989 (Colorado Division of Mines, 1992). Clay mining has occurred within the RFETS buffer zone in the past, but currently takes place outside of the facility boundaries (EG&G, 1992c).

Open space lands are located north and northeast of the RFETS near the city of Broomfield, in small parcels adjoining major drainages, west along the foothills, and as small neighborhood parks in the cities of Westminster and Arvada. Standley Lake to the east of RFETS is surrounded by Standley Lake Park.

Irrigated and nonirrigated croplands, producing primarily wheat and barley, are located northeast of the RFETS near the cities of Broomfield, Lafayette, and Louisville; north of the RFETS near Boulder; and in scattered parcels adjacent to the eastern boundary of the RFETS (DOE, 1992a). In 1987, according to Colorado agricultural statistics, 20,758 acres of croplands were planted in Jefferson County and 68,760 acres were planted in Boulder County. Other crops grown in the region include corn, dry beans, sugar beets, hay, and oats (Post, 1989).

Irrigated corn and oats are grown north of the RFETS toward Louisville and east of the southern end of Boulder (EG&G, 1992c).

Livestock ranges are operated within 10 miles of the RFETS and are utilized to raise beef cattle, supply milk, and breed and train horses (DOE, 1991d). Several horse ranching operations and hay fields are located just a few miles south of the RFETS (DOE, 1992a).

I.4.1.2 Future Land Use

Future land use in the vicinity of the RFETS most likely will involve continued suburban expansion and increased density of residential and commercial land use in the surrounding areas. The expected trend in population growth in the vicinity of the RFETS is demonstrated by comparing the 1989 population data to population projections for the year 2010 (DOE, 1990). The 21-year population-growth profile shows tripling of the population in the vicinity of the RFETS. The DOE estimates are based primarily upon long-term population projections developed by the Denver Regional Council of Governments (DRCOG). Expected population density and distribution around the RFETS in the year 2010 are shown in Figure I.4-3.

The only major, recent (post-1989 DOE population data) housing development within a 5-mile radius of the RFETS is the Rock Creek project in the city of Superior. To date, 530 occupancy permits have been issued for the project, with a maximum of 3,500 to 4,000 single- or multi-units expected to be constructed. This project should be completed by the year 2000 (City of Superior, 1994). The city of Superior does not expect any other significant growth in the area since most of the available land has been purchased for strictly open space use. DRCOG and the Jefferson County Planning and Zoning Department support this conclusion (DRCOG, 1994) (Jeffco, 1994).

Several areas of industrially zoned property are located adjacent to and near the RFETS. These properties are not likely to be developed in the near future due to the lack of water for fire protection. The properties must be admitted to a fire protection district prior to commercial or industrial development. To date, no fire protection district has been willing to accept the property, and it is anticipated that these properties will remain undeveloped in the near future (EG&G, 1992c).

I.4.1.3 Potentially Affected Human Populations

Three potential human receptor population groups can be identified for the RFETS. The first group consists of hypothetical onsite populations and offsite residential populations, both current and future. The second group is onsite workers, both current and predicted. This latter group can be further subdivided into those individuals who engage in light industrial/commercial work and those who engage in remediation- or construction-related activities. Sensitive populations such as children and the elderly comprise the third group.

The current worker population at the RFETS is approximately 7,600. Most of these workers are involved in light industrial and commercial operations. In the near future, additional workers will be required for remediation and associated construction activities. These activities will range from the sampling of various media at the RFETS OUs to the construction of remedial structures. The PRGs have been calculated for these future OU4 workers who may come into contact with contaminated surficial or vadose zone soils. These PRGs are discussed in the human health impact analysis presented in Parts III and IV of this Decision Document.

The school closest to the RFETS is Witt Elementary School, approximately 2.7 miles east of the buffer zone (approximately 5 miles from the center of the RFETS) (DOE, 1991d). All other sensitive facilities, such as hospitals and nursing homes, are located beyond the 5-mile radius from the center of the RFETS. Ninety-three schools, eight nursing homes, and four hospitals are located within a 5- to 10-mile radius of the RFETS (EG&G, 1992c).

The nearest drinking water supply is the Great Western Reservoir, located approximately 2.3 miles east of the center of the RFETS. The city of Broomfield operates a water treatment facility immediately downstream from the Great Western Reservoir. This water treatment facility currently supplies drinking water to approximately 28,000 people. The continued use of the Great Western Reservoir as a drinking water source, however, is limited. The city of Broomfield has, with DOE's assistance, devised a plan to obtain drinking water from other sources distant from the RFETS. The city of Broomfield plans to have the alternative water supply selected and functioning by 1997.

Standley Lake Park is a recreational area and drinking water supply for the cities of Thornton, Northglenn, Westminster, and Federal Heights. The park is located 3.5 miles southeast of the RFETS. Water is piped from Standley Lake to each city's water treatment facility. Boating, picnicking, and limited overnight camping are permitted at Standley Lake Park. After 1997, Standley Lake will be the closest drinking water supply to OU4.

I.4.2 Topography and Geomorphology

The following sections briefly describe the topographical and geomorphological characteristics of OU4 and the RFETS in general.

I.4.2.1 Rocky Flats Environmental Technology Site General Characteristics

The RFETS is situated along the eastern edge of the central Rocky Mountain region immediately east of the Colorado Front Range. As shown in Figure I.4-4, the RFETS is at an average elevation of approximately 5,950 feet above mean sea level (ft msl). The site is located on a broad, eastward-sloping alluvial surface that has been deeply incised in some areas by modern drainage systems. Refer to Section I.4.4.1 for discussion of the drainage features. The surface of the alluvium slopes gently eastward at 88 feet per mile. The average elevation along the western RFETS boundary is 6,140 ft msl and slopes to about 5,700 ft msl along the eastern boundary.

I.4.2.2 Operable Unit 4 Site Characteristics

Topography is relatively level in the SEPs area, except where artificial dikes have been built (Figure I.4-5); however, in OU4 north of the SEPs, the topography shows significant relief. The average elevation in the SEPs area is 5,970 ft msl. The ground surface north of the SEPs slopes steeply through the OU4 area and the ITS toward North Walnut Creek.

At the RFETS, the alluvial surface is dissected by a series of east-northeast trending stream-cut valleys. The valleys, formed by Rock Creek, North and South Walnut Creeks, and Woman Creek, are 50 to 200 feet below the alluvial surface in the vicinity of the RFETS. These valleys are incised into the bedrock, but the bedrock is concealed by colluvial material which has accumulated along the valley slopes, and by valley fill alluvium in stream channels.

I.4.3 Climatology, Meteorology, and Air Quality

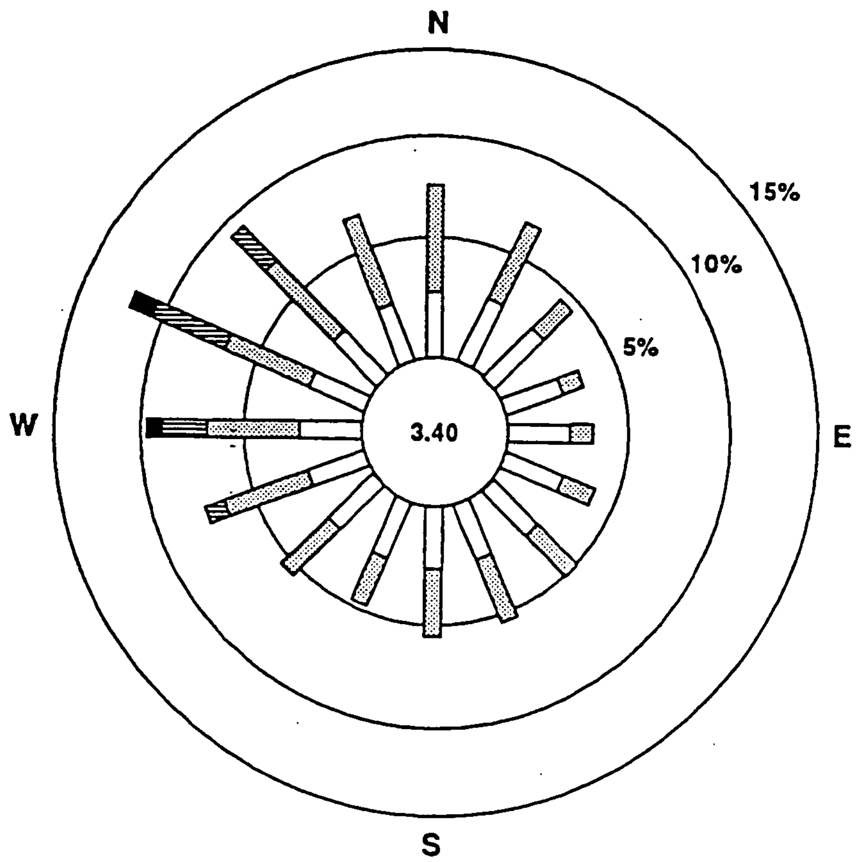
The following two subparts of I.4.3 identify the site's climate, topography, impacts from wind, drainage, temperature, and air quality.

I.4.3.1 RFETS Climatology and Meteorology

The climate at the RFETS is strongly influenced by the Colorado Front Range. The region's semiarid climate is characteristic of much of the central Rocky Mountains. Dry, cool winters with some snow cover, and warm, relatively moist summers are typical.

Regional topography and upper-level wind patterns combine to create a semiarid climate along the foothills of the Colorado Front Range. Precipitation in the RFETS area occurs primarily as snowfall or short-duration thunderstorms. These localized thunderstorms are generally one hour or less in duration, and their areal extent is usually limited to approximately one square mile (ASI, 1991). Precipitation data are collected and recorded by EG&G at the West Buffer Zone Meteorological Station. The 1992 annual precipitation at the RFETS was 14.49 inches (EG&G, 1992b). The long-term average annual precipitation at the RFETS is approximately 16 inches. Although RFETS-specific evaporation data are limited, the annual net reservoir evaporation rate at RFETS is estimated to be 31 inches (EG&G, 1992b).

The orientation of the Front Range affects the local winds. Prevailing northwesterly winds are predominant at the RFETS and are normally channeled across the Rocky Flats pediment. High velocity winds have been recorded at the RFETS with the highest wind velocities occurring most frequently in the spring. Figure I.4-6 illustrates the RFETS wind frequency distribution for 1990-1991.



LEGEND

> 15 m/s	7 - 15 m/s	3 - 7 m/s	1 - 3 m/s	% Calm
> 34 mph	16 - 34 mph	7 - 16 mph	2 - 7 mph	

Source: 1991 Rocky Flats Plant Meteorological Data Base

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Figure I. 4-6

**Solar Evaporation Ponds
Operable Unit No. 4, IM/IRA EA DD
Annual Wind Rose for
Rocky Flats Environmental
Technology Site, 1990-1991**

r85x11

The RFETS is also affected by westerly drainage winds from the Front Range. These air flows, channeled through the Front Range canyons, are especially pronounced under conditions of strong atmospheric stability. Daily cycles of mountain and valley breezes also occur at the RFETS. North to south upslope air movement is also typical for the Denver area, with air flowing up the South Platte River Valley and entering the Front Range canyons. After sunset, the air cools as it contacts the mountain surfaces and moves downslope. Downslope flows converge with the South Platte River Valley flow and move toward the north-northeast.

Strong surface air convections commonly produce thunderstorms during the summer, causing severe and locally unpredictable anomalies in normal air flows. Late winter and spring conditions can be influenced by chinook windstorms that move from west to east over the Continental Divide. Chinooks have been recorded in excess of 100 miles per hour (mph) at the RFETS (EG&G, 1992c).

The temperatures at the RFETS in 1992 averaged a maximum of 77 degrees Fahrenheit (°F) and a minimum of 18°F, with an annual mean temperature of 48.8°F. The recorded RFETS temperature extremes in 1992 ranged from 91°F in July to -4°F in January (EG&G, 1992b). The meteorological data were collected at the meteorological tower located in the northwestern buffer zone. Infrequent cloud cover over the region allows for intense solar heating of the ground surface. The low absolute humidity permits rapid radiant cooling at night. Relative humidity averaged 46 percent for the period from 1954 to 1976.

Special attention has been focused on the dispersion meteorology surrounding the RFETS due to the potential for significant atmospheric releases of contaminants affecting the Denver metropolitan area. Studies of air flow and dispersion characteristics indicate that drainage flows move toward the north and northeast along the South Platte River Valley to the west and north of Brighton, Colorado.

I.4.3.2 Air Quality

National Ambient Air Quality Standards (NAAQS) have been promulgated by the EPA in Title 40, CFR Part 50 for six pollutants, referred to as "criteria pollutants." The CDPHE's Air Quality Control Commission has adopted these standards for its compliance program. Areas of the state where concentrations of any of the criteria pollutants exceed the NAAQS are defined as "non-attainment" areas.

The Denver metropolitan region is considered to be a nonattainment area for the following criteria pollutants: carbon monoxide, particulate matter less than 10 microns (PM-10), and ozone. This nonattainment area encompasses all or parts of Adams, Arapahoe, Boulder, Douglas, Denver, and Jefferson counties. The RFETS is situated in the nonattainment area for all three pollutants.

Routine emissions of both radioactive and nonradioactive air pollutants have occurred from the RFETS, primarily during past operations. These operations were terminated in 1989, greatly reducing the emissions. There were only 12 Air Pollution Emission Notices (APENs - see Note [1] below) submitted to CDPHE in 1993, compared to over 200 in 1989 (EG&G, 1994). The RFETS emissions for nitrogen oxides are potentially greater than 100 tons per year (TPY). The industrial facilities discussed in Section I.4.2.1 are also potential sources of air pollution in the vicinity of the RFETS.

I.4.4 Site and Local Surface Water Hydrology

Three streams, Rock Creek, Woman Creek, and Walnut Creek, drain the RFETS area and generally flow from west to east, as shown in Figure I.4-7. The major drainage basins receiving runoff from OU4 are North Walnut Creek, and, to a lesser extent, South Walnut Creek. North and South Walnut Creeks are intermittent streams with flow occurring primarily after precipitation and snowmelt events. A description of these drainages is presented in the following section.

I.4.4.1 Principal Drainage Basins

Rock Creek drains the northwestern corner of the buffer zone and flows northeastward through the buffer zone to its offsite confluence with Coal Creek. Coal Creek flows into Boulder Creek, St. Vrain Creek, and eventually discharges to the South Platte River. Rock Creek is peripheral to the RFETS.

Woman Creek, a stream originating west of the RFETS, drains the southern buffer zone and flows eastward, discharging into Standley Lake. Mower Ditch flows from Woman Creek in the eastern portion of the RFETS and supplies Mower Reservoir east of Indiana Street (EG&G, 1992e). Woman Creek is not in the OU4 drainage basin (see Figure I.4-7). The South Interceptor Ditch is located between the RFETS and Woman Creek, and collects runoff from the southern part of the RFETS and diverts it to Retention Basin C-2. Water from Retention Basin C-2 is pumped, treated (if necessary), and discharged into the Walnut Creek drainage, where it flows offsite via the Broomfield diversion canal. Most of the remaining surface water runs off into the Woman Creek drainage south of the South Interceptor Ditch.

Walnut Creek is formed by the combined flows from North Walnut Creek and South Walnut Creek, which drain the central and northern areas of the RFETS, respectively. An unnamed tributary also drains the northern part of the RFETS. OU4 is drained primarily by the North Walnut Creek tributary, and by South Walnut Creek to a lesser extent. The three Walnut Creek tributaries join in the buffer zone to form Walnut Creek, which flows eastward to the Great Western Reservoir. However, flow in Walnut Creek is generally diverted around the Great Western Reservoir into Big Dry Creek through the Broomfield Diversion Ditch. The SEPs

Note 1: An Air Pollution Emission Notice must be submitted annually to the CDPHE Air Pollution Control Division for any and all sources of air pollution emissions. An APEN for new sources must be submitted prior to the release of any emissions.

range from approximately 600 to 850 feet south of North Walnut Creek. South Walnut Creek is approximately the same distance away from the SEPs as is North Walnut Creek. Figure I.4-8 presents the extent of the 100-year floodplain for North Walnut Creek. The floodplain slightly overlaps the OU4 area along its northern boundary.

I.4.4.2 Surface Water Control Structures

Surface water management controls are in operation at RFETS. The West Interceptor Trench diverts runoff from the headwaters of North Walnut Creek via the McKay Ditch Bypass to Walnut Creek west of Indiana Street. In addition to ditches and canals, a series of retention ponds has been constructed to control the release of RFETS discharges and to collect surface water runoff.

Runoff in the northern part of OU4 is collected in Retention Basins A-1, A-2, and A-3 located along North Walnut Creek, northeast and downstream of OU4 (See Figure I.4-9). Diversion pipes enable water to bypass Basins A-1 and A-2 and collect in Basin A-3. Basins A-1 and A-2 are currently reserved for general site surface water discharge control. Until 1980, Basins A-1 and A-2 were used for storage and evaporation of laundry water. Basin A-3 receives the North Walnut Creek stream flow and runoff from the northern portion of the RFETS. Basin A-4 is the terminal pond on North Walnut Creek and receives water released from Basin A-3. Water from Basin A-4 currently discharges to North Walnut Creek in accordance with the National Pollutant Discharge Elimination System (NPDES) permit for the RFETS, the Federal Facilities Compliance Agreement (FFCA), and the Agreement in Principle (AIP). This water is treated (if necessary) prior to discharge.

South Walnut Creek begins in the RFETS and receives runoff from the southern portion of OU4. Runoff in South Walnut Creek is collected in Retention Basins B-1 through B-5 located east and downstream of OU4. The runoff flows overland into the portion of the drainage that is within the Protected Area. The runoff enters a culvert system under the Northeast Perimeter Road and flows into a diversion structure located just upstream from Basin B-1. This runoff is normally diverted around Basins B-1, B-2, and B-3 through a bypass line to Basin B-4, although it can be diverted into Basin B-1. Basin B-4 has limited storage capacity and generally passes water directly to Basin B-5.

Basins B-1 and B-2 are spill control ponds that receive water from the South Walnut Creek basin. Water in Basins B-1 and B-2 is kept at low levels in order to maintain capacity for spill control for the sewage treatment plant (STP). Basin B-3 is discharged to Basins B-4 and B-5 in accordance with the provisions of the NPDES permit. Basin B-5 is the terminal pond on South Walnut Creek. Water from Basin B-5 was historically treated and discharged to South Walnut Creek. Currently, excess water in Basin B-5 is transferred by a new pipeline to Basin A-4, where it is treated (if necessary) and discharged to North Walnut Creek according to the NPDES permit, the FFCA, and the AIP.

I.4.4.3 Seeps

Seepage resulting from the discharging ground water has historically been observed on the hillside north of the SEPs, and was documented during the OU4 RFI/RI investigation (See Part II). Seeps occur at the interface of the Rocky Flats Alluvium and the Arapahoe Formation (see Figure I.4-10.). Where bedrock (Arapahoe Formation) claystones are present, seep effluent is from the Rocky Flats Alluvium; where bedrock sandstones or siltstones are found, seep effluent may be from the alluvium and the bedrock. Seepage areas commonly appear to be moist or wet, even though precipitation has not recently occurred. These areas may or may not be marked by the presence of phreatophytes (plant species with roots that extend to the water table). The seeps are not normally point sources of overland flow, and flow rates have not been estimated. Visual observations suggest that most of the seepage currently evaporates or transpires. Historically, however, surface water sampling locations were established at interceptor trenches constructed downslope of these seeps, and water quality data from that sampling are available. (A summary of this data can be found in Part IV.) A distance of approximately 70 feet separates the seeps from the closest SEP's (SEP 207-B North) northwestern edge.

I.4.5 Site and Local Soils

Soils are defined here in this section of the IM/IRA as the material found from the ground surface to a depth of approximately 60 inches. The deeper unconsolidated material is discussed in Section I.4.6.2. Three types of soil have been described by the Soil Conservation Service (SCS) (1983) at the RFETS. These soil types are designated as the following: the Flatiron Series, located on the Rocky Flats Alluvium; the Nederland Series, commonly located on the upper slopes flanking the Rocky Flats Alluvium; and the Denver-Kutch-Midway Series, located on slopes flanking the Nederland soils. All of these soil series have been identified in the OU4 area (SCS, 1983). Figure I.4-11 presents a diagram of the various soils located within and around the RFETS.

The Flatiron Series is a cobbly, sandy loam that exhibits a slow infiltration rate and is located on slopes of 0 to 3 percent. The Denver-Kutch-Midway Series is a clay loam, also exhibiting a slow infiltration rate, and develops on the Arapahoe Formation claystones where slopes range from 9 to 25 percent. The Nederland Series develops adjacent to the Flatiron Series along the periphery of the Rocky Flats Alluvium where slopes range from 15 to 50 percent. The Nederland Series soil exhibits a moderate infiltration rate. All three soil types are partially obscured by fill materials, gravel, or buildings and other structures.

I.4.6 Regional and Local Geology

Significant work has been conducted recently to further characterize the geology at the RFETS. A Geologic Characterization Report for the entire RFETS (EG&G, 1991c) was prepared based on a comprehensive literature search, and describes previously obtained core samples, reprocesses previously obtained seismic data, and analyzes select samples for grain size distribution. A summary of the results of this study, as they pertain to OU4, is presented in the following sections.

I.4.6.1 Regional Setting

The current structural setting of the central Rocky Mountain region is dominated by the subsidence of large basins and the rise of extensive uplifts, such as the Denver Basin and Front Range. For at least the second time, the Front Range area has risen from below sea level to several thousand feet above sea level. This tectonic event occurred during the Laramide Orogeny, approximately 70 to 65 million years ago. Concurrently, the adjacent Denver Basin began and continued to subside to its current structural relief of at least 16,000 feet, measured from the basin bottom onto the flank of the Front Range, a distance of only a few miles.

The Laramie Formation is the youngest pre-Laramide Orogeny sediment package. It is interpreted as a coastal plain deposit and records sedimentation prior to the uplift of the Front Range and subsidence of the Denver Basin. The Laramie Formation consists of alternating yellowish-gray sandstones, varicolored kaolinitic claystones, and siltstones with subbituminous coal beds in the upper part. Laramide sediments, which lie above the Laramie Formation, comprise the Arapahoe and Denver Formations. The Arapahoe Formation, exposed along the Front Range west of Denver, consists of a lower cross-bedded conglomeratic sandstone sequence and an upper sequence of dark gray claystones and mudstones with thin layers of siltstone and sandstone. The lower conglomeratic sandstone sequence is not ubiquitous, and is generally not present at the RFETS. The Arapahoe Formation lies unconformably upon the Laramie Formation and is thought to have been deposited in braided-stream and channel-margin environments.

Structurally, the RFETS is located on the western flank of the Denver Basin, approximately 4 miles east of steeply dipping strata on the eastern flank of the Front Range. West of the RFETS, older sedimentary formations and the Laramie Formation claystones dip approximately 50 degrees to the east. Beneath the RFETS, bedrock flattens to a dip of approximately 3 degrees.

The RFETS is located on a broad, undulating, eastward-sloping pediment surface along the western edge of the Denver Basin. Geologic units beneath the RFETS consist of unconsolidated surficial units including the Rocky Flats Alluvium, younger terrace alluvium (Verdos, Slocum, and Louviers Alluvia), valley fill alluvium, and colluvium (Figure I.4-12). These unconsolidated surficial deposits are unconformably underlain by approximately 10,000 feet of Pennsylvanian to Late Cretaceous sedimentary rocks that have been locally folded and faulted, as shown in Figure I.4-13. Figure I.4-14 presents a generalized stratigraphic section of the Denver Basin bedrock formations. Figure I.4-15 shows a stratigraphic section of the RFETS.

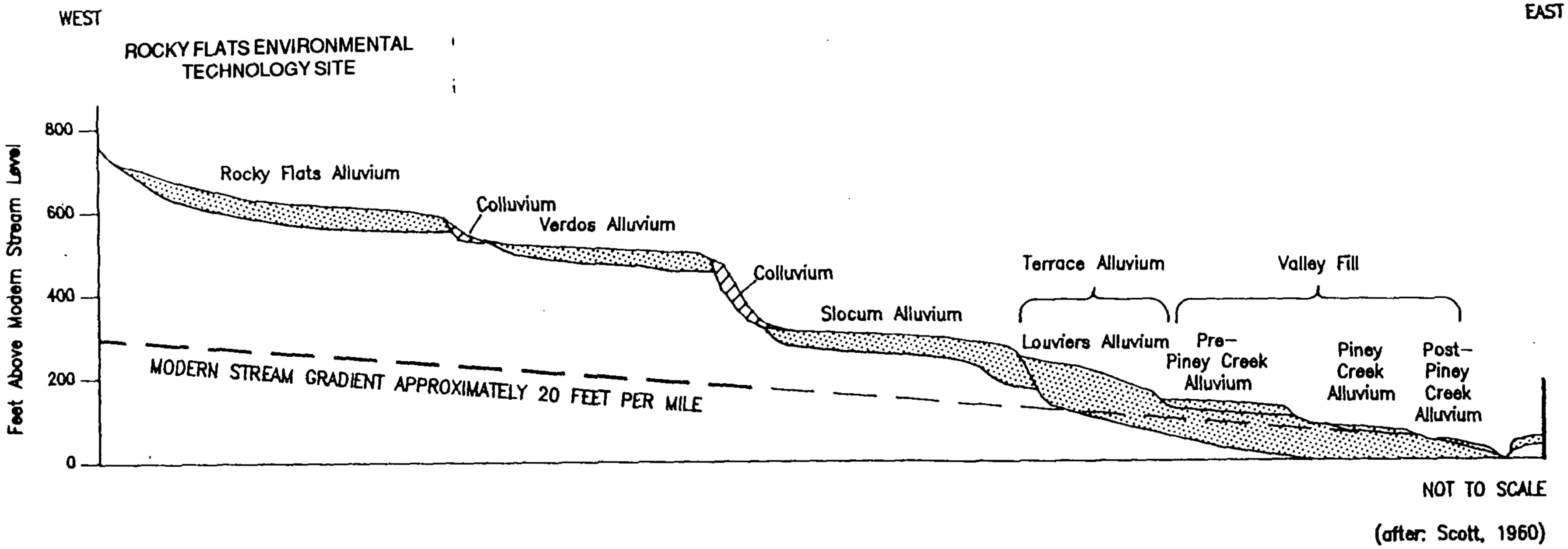

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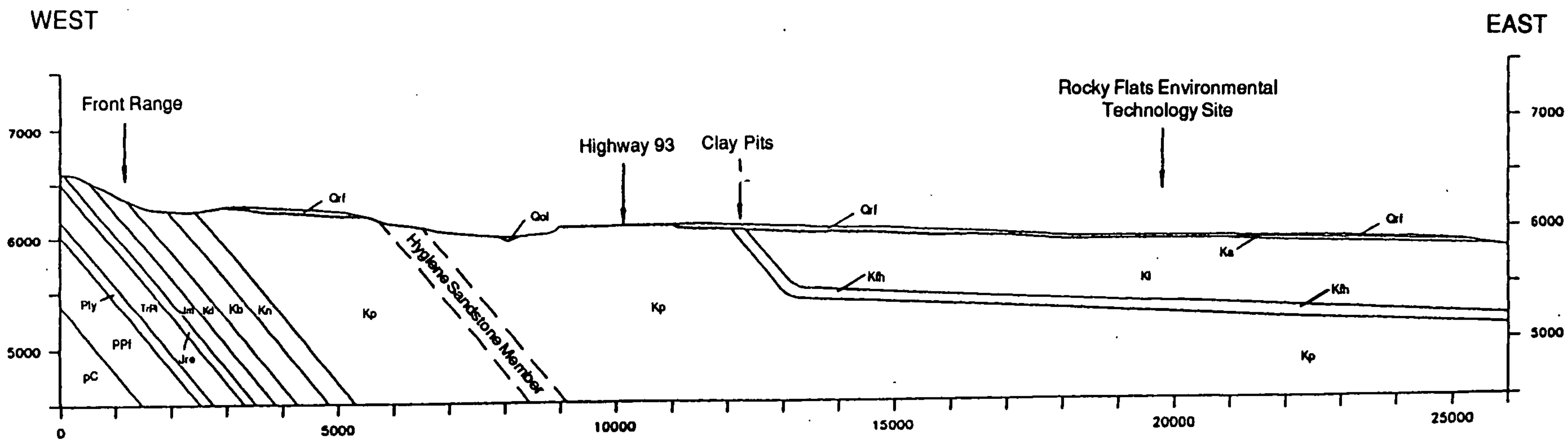
Figure I. 4-12

Solar Evaporation Ponds
Operable Unit No. 4, IM/IRA EA DD
Erosional Surface and Alluvial Deposits East of the Front Range, Colorado

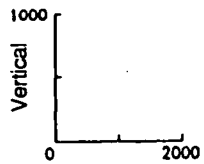
Source: EG&G. 1991. " Draft Final Geologic Characterization Report for the RFP"

rf85x11h



EXPLANATION

Qrf = Quaternary Rocky Flats Alluvium
Qal = Quaternary Valley Fill Alluvium
Ka = Cretaceous Arapahoe Formation
Kl = Cretaceous Laramie Formation
Kfh = Cretaceous Fox Hills Sandstone
Kp = Cretaceous Pierre Shale
Kn = Cretaceous Niobrara Formation
Kb = Cretaceous Benton Shale
Kd = Cretaceous Dakota Group
Jm = Jurassic Morrison Formation
Jrc = Jurassic Ralston Creek Formation
TrPl = Perma-Triassic Lykins Formation
Ply = Permian Lyons Sandstone
PPf = Pennsylvanian-Perrnian Fountain Formation
p€ = Precambrian



Horizontal
Scale in Feet
2x Vertical Exaggeration

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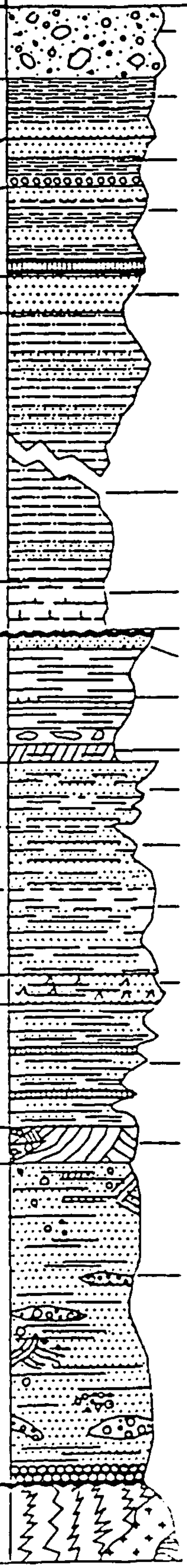
Figure I.4-13

Solar Evaporation Ponds
Operable Unit No. 4, IM/IRA EA DD
Generalized West-East Cross-Section
Front Range to Rocky Flats Environmental
Technology Site

Modified from: Hurr, 1976

rf85x11h



AGE	FORMATION	Thickness (Feet)	SUMMARY DESCRIPTION
TERTIARY	Green Mountain	600'	Boulder conglomerate with occasional thin siltstone lenses
TERTIARY	Denver	870'	Yellowish-brown to grayish-olive fluvial tuffaceous claystone, siltstone, and sandstone interbedded with conglomerate and olive-gray mudflows
UPPER CRETACEOUS	Arapahoe	250'	Yellowish-gray to yellowish-brown sandstone; siltstone and claystone; discontinuous conglomerate at base
UPPER CRETACEOUS	Laramie	700'	Gray, fine-to-medium-grained sandstone and silty clays; thin coal beds in lower part
UPPER CRETACEOUS	Fox Hills	60'	Tan, fine-to-medium-grained sandstone and sandy shale
UPPER CRETACEOUS	Pierre	± 8000'	Dark gray, silty shale and few thin, silty sandstones
UPPER CRETACEOUS	Niobrara	350'	Dark gray, very calcareous shale. "Foraminifers" abundant (Smoky Hills Member) Light gray, dense, fossiliferous limestone (Fort Hays Member)
UPPER CRETACEOUS	Benton	420'	Brown, sandy, fossiliferous limestone Dark gray shale with bentonite streaks; thin limestones in middle part; few cone-in-cone concretions in lower part Dark gray, brittle silty shale (Mowry)
LOWER CRETACEOUS	Dakota Group: So. Platte	270'	Light gray, fine-to-medium-grained sandstone, several dark gray shales in middle part
LOWER CRETACEOUS	Dakota Group: Lytle	100'	Light gray, fine-to-coarse-grained, locally conglomeratic sandstone; frequent red and green siltstone interbeds
Jurassic	Morrison	365'	Gray to greenish-gray to red shale and siltstone; thin limestones in middle part, lenticular sandstones in upper and lower part
Jurassic	Ralston Creek	10	Light tan siltstone and light red, silty shale, gypsiferous, sandstone at base and locally conglomeratic
TRI-ASSIC?	Lykins	400'	Red siltstone with two laminated limestones in lower part
PERMIAN	Lyons	120	Grayish-white, fine-to-medium-grained cross-bedded sandstone; conglomeratic lenses frequent
PENNSYLVANIAN	Fountain	1000'	Red, fine-to-coarse-grained sandstone and conglomerate; arkosic; thin, lenticular red siltstones frequent throughout
PRECAMBRIAN			Gneiss, schist, and small granitic intrusions

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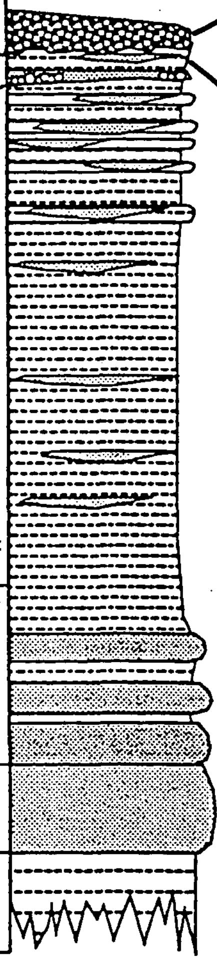
Figure I.4-14

Solar Evaporation Ponds, Operable Unit No. 4, IM/IRA EA DD Generalized Stratigraphic Section of the Denver Basin Bedrock

Source: EG&G. 1991. " Draft Final Geologic Characterization Report for the RFP"

Age	Formation	Thickness (feet)
Quaternary	Rocky Flats Alluvium/ Colluvium	0-100
Cretaceous	Arapahoe Fm.	0-60
	Laramie Formation	600-800 upper interval: 300-500 lower interval: 300
	Fox Hills Sandstone	90-140
	Pierre Shale and older units	



Clayey Sandy Gravels - reddish brown to yellowish brown matrix, grayish-orange to dark gray, poorly sorted, angular to subrounded, cobbles, coarse gravels, coarse sands and gravelly clays; varying amounts of caliche

Claystones, Silty Claystones, and Sandstones - light to medium olive-gray with some dark olive-black claystone, silty claystone, and fine-grained sandstone, weathers yellowish orange to yellowish brown; a mappable, light to olive gray, medium- to coarse-grained, frosted sandstone to conglomeratic sandstone occurs locally at the base (Arapahoe marker bed)

Claystones, Silty Claystones, Clayey Sandstones, and Sandstones - kaolinitic, light to medium gray claystone and silty claystone and some dark gray to black carbonaceous claystone, thin (2') coal beds and thin discontinuous, very fine to medium-grained, moderately sorted sandstone intervals

Sandstones, Claystones, and Coals - light to medium gray, fine- to coarse-grained, moderately to well sorted, silty, immature quartzose sandstone with numerous claystones, and subbituminous coal beds and seams that range from 2' to 8' thick

Sandstones - grayish orange to light gray, calcareous, fine-grained, subrounded, glauconitic, friable sandstone

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Figure I.4-15

Solar Evaporation Ponds
Operable Unit No. 4, IM/IRA EA DD
Generalized Stratigraphic Section of the
Rocky Flats Environmental Technology Site

Source: EG&G. 1991. " Draft Final Geologic Characterization Report for the RFP"

I.4.6.2 Solar Evaporation Ponds Area Geology

The SEPs are located on a pediment that is capped by the Rocky Flats Alluvium. The erosional pediment surface was cut by pre-Rocky Flats Alluvium eastward-flowing streams. Pedimentation was further enhanced, to a smaller degree, by erosion associated with deposition of the Rocky Flats Alluvium. At the RFETS, incised pediment channels have up to approximately 30 feet of cross-sectional relief. In the OU4 area, however, channel relief is less than 10 feet. From west to east across the RFETS, for approximately 3.4 miles, the alluvial pediment surface declines 300 feet in elevation, exhibiting a slope of approximately 88 feet per mile. Refer to Part II for further discussions on OU4 geology.

The surficial deposits that unconformably overlie the pediment surface in the OU4 SEPs area consist of the Rocky Flats Alluvium, colluvium, valley fill alluvium, and artificial fill. Based on local mapping (Hurr, 1976; Shroba, 1994), nearly all of the industrial area at the RFETS is underlain by Rocky Flats Alluvium. These sediments are covered by thin soils, colluvium, artificial fill materials, and RFETS structures. Unconsolidated colluvial and valley fill alluvium deposits are found topographically below the Rocky Flats Alluvium in drainages or on slopes. In OU4, these materials attain a maximum thickness of approximately 30 feet on the northern slope of North Walnut Creek.

Most of the surficial SEPs area has been disturbed by construction of the SEPs, the ITS, nearby buildings, and other infrastructure. Borehole logs suggest that the Rocky Flats Alluvium often occurs below the limits of the disturbed ground. The thickness of the entire unconsolidated interval in the OU4 area ranges from 0 to approximately 35 feet, averaging about 10 feet. The Rocky Flats Alluvium and the other previously mentioned unconsolidated units are discussed below.

<u>Quaternary Formations</u>

<u>Rocky Flats Alluvium</u>: The Rocky Flats Alluvium was deposited during the Pleistocene epoch of the Quaternary period as a broad, flat, eastward-sloping alluvial fan with its apex at the mouth of Coal Creek Canyon. The Rocky Flats Alluvium underlies nearly all buildings and facilities at the RFETS, if it has not been removed and replaced with artificial fill materials. Sitewide, the thickness of the Rocky Flats Alluvium ranges up to 100 feet. In the OU4 area, alluvial thickness ranges from less than 10 feet to slightly more than 20 feet. The Rocky Flats Alluvium is absent where it has been removed by erosion and down-cutting of South Walnut, North Walnut, and Woman Creeks.

The Rocky Flats Alluvium occurs on top of the erosional bedrock surface in the SEPs area. Lithologically, it is composed of poorly to moderately sorted, and stratified gravel, sand, silt, and clay. The coarse clastic materials were derived primarily from Front Range source areas composed of Precambrian crystalline metaquartzites, schists, and younger granitoids. Fine clastics are derived from the chemical and mechanical weathering of these crystalline rocks. This unit contains clasts ranging in size from boulder to pebble, and matrix material that ranges in size from clay to sand. Colors include light to gray brown, dark yellowish orange, grayish orange, and dark gray. The material is mildly to highly calcareous and weakly to strongly cemented. Locally, bedrock is exposed in eastward-flowing stream drainages that have dissected the alluvium. This unit also contains clasts and a matrix of reworked bedrock materials that can be difficult to distinguish from the true bedrock surface during drilling.

Colluvium: Colluvium occurs on hill slopes which descend to North and South Walnut Creeks, northeast and southeast of the SEPs, respectively. These deposits are derived from the Rocky Flats Alluvium and the underlying bedrock. Most bedrock at the RFETS is concealed beneath colluvial material that consists of unconsolidated clay, silty clay, sandy clay, and gravel layers with sparse cobbles. Colors vary from dark yellowish brown to light olive gray and light olive brown.

Valley Fill Alluvium: Valley fill alluvium is the youngest surficial deposit within OU4 and occurs along the bottom of stream valleys. Minor linear wetlands are found on this unit. Valley fill alluvium consists of unconsolidated, poorly sorted sand, and gravel in a silty clay matrix. Colors range from olive gray to dark yellowish orange to dark yellowish brown.

Disturbed Ground: Ground disturbed by construction of the SEPs, ITS, and nearby buildings overlies the Rocky Flats Alluvium and bedrock in the SEPs area, and overlies colluvium on the hill slopes in the ITS area. Disturbed ground consists of unconsolidated clay, silt, sand, and gravel derived from the Rocky Flats Alluvium and colluvium. Colors range from olive to reddish brown to yellow gray and yellow orange.

Artificial Fill: Geologic materials native to the site (Rocky Flats Alluvium) and imported offsite materials have been used as fill in the SEP area for road grade and berm construction, for re-contouring around engineered structures, and as fill in topographic lows for construction of surface impoundments. Imported crushed rock has also been used for landscaping and leveling at the site. Artificial fill generally consists of sandy clay and gravel. These materials are poorly sorted with fragments of claystone and concrete rubble. Colors range from pale to dark yellowish brown.

Late Cretaceous Bedrock Formations

The Late Cretaceous Arapahoe Formation is unconformably overlain by surficial materials at the RFETS (Figure I.4-15). The Arapahoe Formation was weathered and eroded during pedimentation and eventually was covered by the Rocky Flats Alluvium. Results from a recent field mapping program (EG&G, 1992d) suggest that the Arapahoe Formation is generally less than 50 feet thick at OU4. The depth of the unconformable contact between the Arapahoe Formation and the underlying Laramie Formation is variable, but is probably no greater than 50 feet below the regional pediment unconformity at OU4. Where subcropping Arapahoe sandstones are not found, the Arapahoe-Laramie Formation contact may be moreproximal to the regional unconformity. Further, it is possible for the Laramie Formation to be in direct unconformable contact with surficial deposits in some locations, particularly in the bottom of modern stream drainages.

A subcropping sandstone has been mapped in the vicinity of SEP 207-C and along South Walnut Creek. There are three principal mappable units: sandstones, siltstones, and claystones (Figure I.4.16). Laterally, these units are intercalated, transitional, and gradational. Stratigraphically, the base of the channel sandstones are incised or eroded into the siltstones or claystones they rest upon. Recent studies (EG&G, 1993c) suggest the claystones beneath the channel sands may be of Laramie Formation age.

Arapahoe Sandstones: At OU4, the Arapahoe Formation is composed primarily of claystone and silty claystone; however, a subcropping sandstone body occurs locally in the vicinity of SEP 207-C. Most of this sandstone is very fine-grained to medium fine-grained, poorly to moderately sorted, subangular to subrounded, silty, and clayey. Some coarse-grained to conglomeratic sandstone has been found in basal portions of sandstone lenses outside of the OU4 area. The medium- and coarser-grained clasts are often frosted. Trough and planar cross-stratification are common sedimentary structures in these sandstones (EG&G, 1992d). The sandstones dip approximately 2 degrees to the east and are generally weathered to a depth of 30 to 40 feet below the base of the Rocky Flats Alluvium. The weathered sandstone varies in color from pale orange to yellowish gray to dark yellowish orange. Unweathered sandstones are light to olive gray. Fractures have been noted in the weathered zone at depths of 5 to 14 feet. These sandstones are lenticular, laterally discontinuous, intercalated with thin lenses of claystone and siltstone, and are interpreted as fluvial system deposits.

Arapahoe Claystones/Silty Claystones: The Arapahoe claystones and silty claystones are massive and blocky, and contain thin laminae and stringers of sandstone, siltstone, and lignite. The weathered claystones extend to approximately 30 feet below the base of the Rocky Flats Alluvium and perhaps farther. Weathered claystones range in color from pale yellowish brown to light olive gray and are moderately stained with iron oxides. Unweathered claystones are typically dark gray to yellowish gray.

Fractures in weathered claystone have been observed between 6 and 26 feet in depth. These fractures are commonly filled with ironstone concretions or iron oxide staining, manganese oxide, and calcareous (caliche) deposits. Small horizontal to vertical fractures have also been observed in the unweathered zone at depths of 30 feet to over 100 feet. Many of the shallower fractures in unweathered lithologies are also stained with oxides, implying water movement (Rockwell, 1988).

Laramie Formation: The Late Cretaceous Laramie Formation unconformably underlies the Arapahoe Formation and is estimated to be approximately 700 feet thick at the RFETS. The Laramie Formation is divided into two intervals: a lower 300-foot thick unit composed of sandstone, siltstone, claystone, and economically viable coal deposits;

and an upper 400-foot thick unit composed predominantly of claystones with occasional lenticular laminated sandstones (Weimer, 1973; EG&G, 1992d). The lower-unit sandstones are fine- to coarse-grained, poorly sorted, subangular, and silty. The upper unit contains light- to medium-gray kaolinitic claystones with sparse, dark gray to black carbonaceous claystones and fine-grained sandstones. The Laramie Formation is interpreted as having been deposited in coastal or transitional marine deposits (EG&G, 1991c).

I.4.7 Regional and Local Hydrogeology

This section describes the hydrogeology of the RFETS and specifically the OU4 study area, including the unconfined and confined ground water systems present at the RFETS. Unconfined ground water flow occurs in unconsolidated geologic materials (Rocky Flats alluvium, valley fill alluvium, and colluvium) and in subcropping bedrock (Arapahoe Formation) sandstones. Since unconfined flow occurs in more than one stratigraphic unit, the term "Upper Hydrostratigraphic Unit" (Upper HSU) is used to reference strata in which unconfined flow occurs. The Upper HSU also includes some saturated subcropping claystones that are weathered and fractured. Ground water flow in the lower (Laramie Formation) sandstone units, and in saturated zones of deeper (Laramie Formation) claystones with sufficient hydraulic conductivity, occurs under confined conditions. This deeper confined aquifer system is referred to as the "Lower Hydrostratigraphic Unit" (Lower HSU) to avoid confusion with the upper unconfined unit.

I.4.7.1 Regional Setting

The RFETS is situated in a regional ground water recharge area. Regionally, ground water flows from west to east in the Upper HSU and along the Arapahoe Formation-alluvium contact where the subcropping Arapahoe Formation consists of claystones, with local flow direction variations along drainages and bedrock topographic highs. Arapahoe Formation claystones have a low hydraulic conductivity (K), on the order of 10^{-7} cm/sec (approximately 0.1 feet per year (ft/yr)), effectively constraining much of the surficial recharge flow to the Upper HSU (see Parts II & III). Surficial recharge flow is further confined to the Upper HSU by the low K exhibited by upper Laramie Formation claystones which underlie the Arapahoe Formation sandstones of the Upper HSU.

The Upper HSU is characterized by rapid changes in water table elevation in response to short-term precipitation events. This is evident from the water level measurements taken from the ground water monitoring wells before and after precipitation events. Water levels in the Upper HSU are generally highest in spring and early summer and lowest during the winter months. In the western part of the RFETS, where the thickness of the surficial material is greatest, the depth to the water table (top of Upper HSU) is about 50 to 70 feet bgs. Although the water table depth is variable, it becomes shallower from west to east as the surficial material thins. Seeps are common in the stream drainages at the base of the Rocky Flats Alluvium, or where Arapahoe Formation sandstones are exposed.

The lower sandstone unit of the Laramie Formation and the underlying Fox Hills Sandstone comprise an important aquifer in the Denver Basin known as the Laramie/Fox Hills aquifer, referred to herein as the Lower HSU. The thickness of the aquifer near the center of the Denver Basin ranges from 200 to 300 feet. These formations outcrop west of the RFETS along the Front Range and dip between 45 and 50 degrees to the east. The dip of these formations decreases to less than 2 degrees beneath the central part of the RFETS. Ground water recharge to the Lower HSU occurs as precipitation and runoff infiltrates bedrock at the steeply dipping and eroded ends of the strata along the western limb of the monoclinal fold.

I.4.7.2 Solar Evaporation Ponds Area Hydrogeology

Characterization of the ground water flow regime at the RFETS OU4 is based on borehole geologic logs, water level measurements in monitoring wells, data gathered from piezometers and neutron access tubes, and aquifer testing. Additionally, water levels are measured monthly by piezometers, and ground water samples are collected quarterly from ground water monitoring wells.

Recharge to the Upper HSU is principally from upgradient areas to the west of the RFETS; however, a portion of the recharge to the Upper HSU occurs from the unconsolidated surficial materials and subcropping permeable bedrock throughout the RFETS area. Recharge also occurs as a result of surface water infiltration from streams, ditches, and ponds. Baseflow of some of the streams is sustained by runoff or ground water discharge. The majority of ground water in the Upper HSU is discharged at seeps along the base of the Upper HSU on slopes along the edges of North Walnut Creek or flows through colluvium downgradient into North Walnut Creek. The remaining ground water continues flowing east in the Upper HSU out of OU4, and a smaller undetermined amount of ground water in the Upper HSU percolates downward into the Lower HSU. The claystones within the upper Laramie Formation have low hydraulic conductivities (10^{-8} cm/sec) and retard downward ground water movement from the Upper HSU to the Lower HSU (DOE, 1992g). The Rocky Flats Alluvium thins due to erosion east of the RFETS boundary and does not act as a recharge source for wells located downgradient of the RFETS.

Recharge areas within OU4 include the industrial area, where a reduced area of surficial soil is exposed to incident precipitation as a result of extensive paving and building construction. Therefore, recharge to the Upper HSU is reduced and surface water runoff is increased. Precipitation runoff is collected by stormwater drains and roadside ditches for discharge into North Walnut Creek.

A variety of data regarding the hydraulic conductivities of geologic materials at the RFETS are available. Aquifer tests were conducted in OU1 and consisted of packer tests of lithologies in the Laramie Formation (Lower HSU), and slug and drawdown tests of valley fill alluvium and colluvium (Upper HSU) in Woman Creek (DOE, 1992g). Pump testing was conducted in the Rocky Flats Alluvium and Arapahoe Formation sandstones (Upper HSU) within OU2 and at selected background sites at the RFETS (DOE, 1992g; DOE, 1991). Among other findings, these tests concluded that the Rocky Flats Alluvium and subcropping Arapahoe Formation sandstones are hydraulically connected. A summary of these results follows:

Geologic unit	Average K Magnitude	Study
Valley fill Alluvium	10^{-3}	DOE, 1992g
Colluvium	10^{-5}	DOE, 1992g
Rocky Flats Alluvium	10^{-2}-10^{-6}	DOE,1992g,1992h,1991d
Weathered Arapahoe sandstone (Upper HSU)	10^{-3}-10^{-6}	DOE, 1991d
Unweathered Arapahoe claystone (Upper HSU)	10^{-7}	IM/IRA EA DD
Weathered Laramie claystone (Lower HSU)	10^{-5}-10^{-7}	DOE, 1992g
Unweathered Laramie claystone (Lower HSU)	10^{-6}-10^{-8}	DOE, 1992g

There are numerous bedrock monitoring wells in the OU4 area. In places where the uppermost sandstone (Upper HSU) is separated from the surficial materials by claystones and silty claystones, the sandstone may exhibit, for a limited area, confined aquifer conditions. Deeper bedrock wells screened in stratigraphically lower sandstones (Lower HSU) and bounded by relatively impermeable claystones also exhibit confined aquifer conditions.

Relatively little hydrogeologic characterization work has been done on the vadose zone at RFETS. The most current data on the vadose zone within OU4 are presented in Parts II and III of this document.

I.4.8 Ecology

The following sections describe vegetation, aquatic life, wildlife, threatened or endangered species, and sensitive environments at the RFETS and specifically OU4.

I.4.8.1 Rocky Flats Environmental Technology Site Ecology

A variety of plant life is found at the RFETS. The predominant vegetation found on the western portion of the site is disturbed mixed prairie, a mixture of both short- and mid-length grasses. The eastern portion of the RFETS is generally highly disturbed from overgrazing, and short grasses are dominant. Common grasses include smooth brome (*Bromus inermis*), crested wheatgrass *(Agropyron cristatum)*, mountain muhly *(Muhlenbergia montana)*, and western wheatgrass (*Agropyron smithii*). Sedges (*Carex nebraskensis*) and rushes (*Juncus arcticus*) are found in stream floodplains and wet valley bottoms. Cottonwoods (*Populus sargentii*), baltic rush *(Juncus balticus)*, and cattails (*Typha latifolia*) line many riparian areas. Other species include salsify (*Tragopogon dubius*), kochia (*Kochia scoparia* and *iranica*), white sweet-clover (*Melilotus alba*), Canada thistle *(Cirsium arvense)*, and spike-rush. Since acquisition of the buffer zone property, vegetative recovery has occurred, as evidenced by the presence of disturbance-sensitive species such as big bluestem (*Andropogon gerardii*) and side oats grama (*Bouteloua curtipendula*). Figure I.4-17 illustrates the location of upland habitats at the RFETS.

Aquatic ecosystems present within the RFETS include perennial and intermittent streams, and human-made ditches, canals, ponds, and reservoirs. The principal components of the aquatic ecosystems are the periphyton, photoplankton, benthic macroinvertebrates, amphibians, and fish. The types of aquatic communities and diversity of species in each of these components are dependent on the type of substrate, water characteristics (such as depth and flow regime, water quality, and creek or pond morphology), water management practices, and season. Fish species are mostly absent in the intermittent streams, but are abundant in the larger ponds and reservoirs (DOE, 1992d).

Animal populations within the RFETS are representative of species typical of western prairie regions. A chain-link fence surrounding the industrial area effectively limits the habitat of the most common large mammal, the mule deer (*Odocoileus hemionus*), to the buffer zone. There are a number of small carnivores within the buffer zone, such as the coyote (*Canis latrans*), red fox (*Vulpes vulpes*), striped skunk (*Mephitis mephitis*), long-tailed weasel (*Mustela frenata*), and the feral cat. Small herbivores are common throughout the RFETS complex and buffer zone, including the pocket gopher (*Thomomys sp.*), white-tailed jackrabbit (*Lepus townsendii*), deer mouse (*Peromyscus maniculatus*), western harvest mouse (*Reithrodontomys megalotis*), and meadow vole (*Microtus pennsylvanicus*) (DOE, 1980).

Commonly observed birds include the horned lark (*Eremophila alpestris*), western meadowlark (*Sturnella neglecta*), mourning dove (*Zenaidura macroura*), vesper sparrow (*Pooecetes gramineus*), western kingbird (*Tyrannus verticalis*), black-billed magpie (*Pica pica*), American robin (*Turdus migratorius*), English sparrow (*Passer domesticus*), house finch (*Carpodacus mexicanus*), Say's phoebe (*Sayornis saya*), barn swallow (*Hirundo rustica*), starling (*Sturnus vulgaris*), and yellow warbler (*Dendroica petechia*). Mallards (*Anas platyrhynchos*) and other ducks (*Anas spp.*) often nested on several of the SEPs when they were in operation. Killdeer (*Charadrius vociferus*) and red-winged blackbird (*Agelaius phoeniceus*) are found in areas adjacent to the SEPs. Birds of prey commonly seen in the area include the marsh hawk (*Circus cyaneus*), red-tailed hawk (*Buteo jamaicensis*), ferruginous hawk (*Buteo regalis*), rough-legged hawk (*Buteo lagopus*), American kestrel (*Falco sparverius*), swainson's hawk (Buteo-swainsoni) and the great horned owl (*Bubo virginianus*) (DOE, 1980).

Rattlesnakes (*Crotalus viridis*) and bullsnakes (*Pituophis melanoleucus*) are the most frequently observed reptiles. Eastern yellow-bellied racers (*Coluber constrictor falviventris*) have also been observed. The eastern short-horned lizard (*Phrynosoma douglassi*) has been reported on the site, but these and other lizards are not commonly seen. The western painted turtle (*Chrysemys picta*) and the western plains garter snake (*Thamnophis radix*) are found in and around many of the ponds on the RFETS property (DOE, 1980).

Rocky Flats Environmental Technology Site Threatened or Endangered Species

Threatened or endangered plant and animal species that could potentially occur at the RFETS have been identified. Plant species identified as threatened, endangered, or special-species status are the forktip threeawn (*Aristida basiramea*), Colorado butterfly plant (*Gaura neomexicana*), Toothcup (*Rotala ramosior*), and Diluvium Lady's Tresses (*Spiranthes diluvialis*). None of the vegetative species present at the RFETS is reported to be on the threatened or endangered species list (DOE, 1991a). Only the forktip threeawn (special status plant) has been observed at the RFETS (EG&G, 1992c). Threatened or endangered wildlife species that could potentially occur at the RFETS include the bald eagle (*Haliaeetus leucocephalus*), peregrine falcon (*Falco peregrinus*), whooping crane (*Grus americana*), the preebles meadow jumping mouse (*Zapus hudsonium prebleii*) and blackfooted ferret (*Mustela nigripes*). Bald eagles have been observed soaring over the RFETS developed area and flying over the northeastern portion of the buffer zone. Two peregrine falcons were observed at the RFETS in early fall of 1991, and noted in the "Final Habitat Survey Report." (EG&G, 1992c). The preebles meadow jumping mouse has been identified to inhabit the area along the banks of North Walnut Creek. Ongoing OU investigations are providing site-specific biological data for plant and animal communities. Refer to the following documents for a complete listing of plant and animal species observed or with the potential to occur at the RFETS:

U.S. Department of Energy (DOE) 1980
Final Environmental Impact Statement

U.S. Department of Energy (DOE) 1991
Baseline Wildlife/Vegetation Studies Status Report
Rocky Flats Plant, Golden, CO

U.S. Department of Energy (DOE) 1991
Final Habitat Survey Report Fish and
Wildlife Coordination Act Migratory Bird
Treaty Act Compliance. 881 Hillside French
Drain (881-HFD) Project.
Rocky Flats Plant, Golden, CO

EG&G 1991
Threatened and Endangered Species Evaluation
Rocky Flats Plant, April, 1991

EG&G 1992
Environmental Restoration Technical Support
Document: A NEPA Support Document for Rocky Flats Plant

<u>Rocky Flats Environmental Technology Site Sensitive Environments (Riparian and Wetland Areas)</u>

The U.S. Army Corps of Engineers (USACE) defines wetlands as "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (U.S. Department of Defense, 1987 *Corps of Engineers Wetlands Delineation Manual*). Wetland assessments have identified a variety of wetland areas at the RFETS including intermittent streams, hillside seeps, several ponds, and an open lake. Many of the RFETS wetlands were classified based on the U.S. Fish and Wildlife Service wetlands classification system. Palustrine, and to a much lesser extent, riverine and lacustrine, wetland types were identified and mapped for the RFETS (ASI, 1990). There are approximately 107 acres of aerial wetlands and 84,970 feet of linear wetlands within the boundaries of the RFETS (see Figure I.4-18 for illustration of the 3 small wetlands relevant to OU4 and the RFETS security zone). Wetland vegetation includes cattails, willows, cottonwoods, and some grasses and forbs (EG&G 1992f).

I.4.8.2 Operable Unit 4 Ecology

OU4 consists of three basic habitat types in the industrial area and on the hillside north of the SEPs:

- Reclaimed Grassland - Grasses include smooth brome, crested wheatgrass, and western wheatgrass. Small inclusions of shortgrass steppe/xeric mixed grassland exist on the eastern edge of the slope.

- Disturbance/Barren Lands - The land is mostly bare with some annual grasses and forbs on the perimeter, grading into the reclaimed grassland. A seepage area is also present in this habitat that supports some sedges and grasses.

- Tall Marsh and Short Marsh - The tall marsh is characterized by cattail and baltic rush. Other dominant species include Canada thistle (*Cirsium arvense*) and spikerush (*Eleocharis sp.*). The short marsh is associated with the seeps from the alluvium-bedrock interface and along the lower edge of the tall marsh habitat. These two habitat types are not extensive and occur as inclusions in the reclaimed grassland habitat.

The OU4 area has been disturbed and contains limited habitat. Vegetation consists almost entirely of disturbed reclaimed grasslands with few shrubs. There is a large weedy component in disturbed areas. Revegetation includes a combination of introduced species and native species that either persisted or seeded naturally. The most common introduced species are smooth brome (*Bromus inermis*), crested wheatgrass (*Agropyron cristatum*), and western wheatgrass (*Agropyron smithii*). Western wheatgrass is the native species that is predominant in the moist areas, and mountain muhly (*Muhleubergii montana*) is predominant on the drier eastern portion of the area. The seeps are dominated by cattails (*Typha latifolia*) and baltic rush (*Juncus balticus*) with smaller areas of spike rush on the edges of the seeps. Weeds are common along roads and around wells and drilling sites that are subject to continual disturbance. Forbs and weedy species encountered include Canada thistle (*Cirsium arvense*), white sweet-clover (*Melilotus alba*), Kochia (*Kochia scoparia and iranica*), salsify (*Tragopogon dubius*), mustards, and annual grasses.

Aquatic life is not present in the OU4 area; there are no permanent or intermittent streams. The SEPs do not support aquatic life and are currently being dewatered.

Live trapping conducted in the SEPs area suggests that animal species in OU4 include the deer mouse (*Peromyscus maniculatus*) and western harvest mouse (*Reithrodontomys megalotis*) and the preebles meadow jumping mouse (*Zapus hudsonium prebleii*), although populations are lower than expected. Field observations also suggest that the feral cat is the predominant predator in OU4, which may, in part, account for the relatively unsuccessful live mammal trapping. In addition, the unsuccessful trapping effort supports the conclusion that the highly disturbed OU4 area is not reflective of natural regional ecosystems. Other potential predators include the great horned owl (*Bubo virginianus*), American kestrel (*Falco sparverius*), and red fox (*Vulpes vulpes*). Common birds found to be nesting within the SEPs area were the English sparrow (*Passer domesticus*), house finch (*Carpodacus mexicanus*), American robin (*Turdus migratorius*), Say's phoebe (*Sayornis saya*), barn swallow (*Hirundo rustica*), starling (*Sturnus vulgaris*), ducks *(Anus spp.)*, and killdeer (*Charadrius vociferus*). Other wildlife species were also identified as feeding within the OU4 area, but not nesting.

Operable Unit 4 Threatened or Endangered Species

Previous and ongoing environmental surveys at the RFETS have suggested that the OU4 area has few ecological attributes within its own boundaries. As discussed in previous vegetation sections, the ecosystems and habitats at OU4 have been highly altered by construction and operation of the ponds and other surrounding facilities, and there is no report of threatened or endangered plants existing in the immediate vicinity of the SEPs. Due to the intense disturbance in industrialized areas, there are no natural ecosystems present immediately around the SEPs, although OU4 has some vegetation resulting from a reseeding program and natural reseeding and colonization by some wide-ranging and hardy species (EG&G, 1993b). Given the conditions in OU4, threatened, endangered, or sensitive ecological populations would not be expected to inhabit or make use of the area for feeding purposes. Furthermore, there is no evidence of rare or endangered populations existing within the OU4 boundaries.

The Preebles Meadow Jumping Mouse (Zapus hudsonium prebleii) has been identified to inhabit the area along the banks of North Walnut Creek. It is perceived that the OU4 buffer zone area may be used by this species for foraging. The Preebles Meadow Jumping Mouse is currently under consideration by the U.S. Fish and Wildlife Service for listing under the Endangered Species Act as a Federal endangered species. The species is currently a State of Colorado listed "Species of Special Concern." The DOE will conduct a habitat study during the 1995 fiscal year to assess whether the remediation of the OU4 buffer zone will impact the habitat used by this species. The results of the study may have an impact on the remediation plans for any area determined to be a habitat for this species. Remediation plans could be terminated for these areas; however, the life cycle of the Preebles Meadow Jumping Mouse includes an approximate 6 month hibernation period. Remediation work could be scheduled during the lengthy period of hibernation so that the mouse would not be impacted.

Operable Unit 4 Sensitive Environments (Riparian or Wetland Areas)

There are at least three small wetland areas towards the bottom of the slope just north of the solar ponds that have not been classified as jurisdictional wetlands during the 1990 Rocky Flats Plant wetlands assessment (EG&G, 1990). Although it has been stated that there are no artificial or natural wetlands within the OU4 area (DOE, 1991a EG&G, 1992c and EG&G, 1990), there are at least three small sites that would meet the vegetation, soil, and hydrology wetlands criteria. During the 1993 Corps of Engineers delineation, the corps acknowledged that there were significant wetlands areas within OU4. In August of 1994, the SEP area was investigated by DOE to establish if any wetland species inhabited the OU4 area. The DOE assessed that there were no wetland species within the immediate area of the SEP's, but that three wetlands existed along the northern hillside.

There are three small wetland areas towards the bottom of the north slope that had not been classified as jurisdictional wetlands during the 1991 "Rocky Flats Plant Wetlands Assessment". Figure I.4-18 provides a map of the OU4 north hillside which delineates the extent of the wetland areas.

Area A is the largest of the areas and is dominated by the broad-leaf cattail, an obligate species. This site is saturated to the surface and water flows into it from a ground water seeps. Surface water drainage patterns also lead into the area.

Area B is located about 20 feet east of Area A, and is smaller. This area had species of *Carex* and *Juncus*, most of which are facultative wetland or obligate species. This area was also saturated to the surface and is downgradient from a ground water seep. Surface water would also flow into this area.

Area C is located to the east of the other wetland areas and north of SEP 207-A. It has a *Tamarix* plant on it which is a facultative wetland indicator species. Also in this area are *Panicum* species, which are facultative, and Fox-Tail Barley, also a facultative wetland species. This area was not saturated to the surface and there are no open ground water seeps.

These three areas are all located within a single soil type on the soil conservation survey (SCS) Golden Area Soil Survey. The type is Denver-Kutch-Midway, with inclusions of Englewood, Hill, and Midway. The SCS does not list this type as hydric soil, but a soil scientist at the SCS says that there are specific sites of hydric-type soils in that mapping unit.

The DOE has estimated the number of square feet for each of the three wetland areas. The approximate area is as follows:

Area A	=	3,430 sq. ft.
Area B	=	1,245 sq. ft.
Area C	=	612 sq. ft.
Total	=	5,287 sq. ft (approximately 0.12 acres)

Figure I.4-18 also depicts the seep line where the ground water table intercepts the surface. It should be noted that the wetland areas are north of the seep line (downgradient).

I.4.9 Social and Economic Resources

The following 4 subparts to I.4.9 detail the site's potential for future use based on cultural response surveys, visual resources, recreational possibilities, and public road access.

I.4.9.1 Site, Local Cultural, and Archeological Resources

Two large-scale and at least two small-scale cultural resource surveys have been completed for 5,900 acres of the RFETS (EG&G, 1992c). Areas excluded from survey were the inner RFETS zone now known as the Protected Area and all designated solid waste management units. These surveys recorded 37 cultural resource sites and 26 isolated finds. Thirty-five sites were dated from the 1870s through the mid-1900s, and were associated with agriculture and ranching. Ditches, stock watering ponds, building remains, a trash dump, rock piles, corrals and an orchard are examples of historic sites (EG&G, 1992c). Two Native American occupation sites were also recorded. These sites consisted of low circular rock piles and a series of linear stone alignments. No artifacts were associated with either of these sites. The 35 historic sites do not qualify for eligibility on the National Register of Historic Places, and no eligibility recommendations have been made for the two Native American sites (EG&G, 1992c).

I.4.9.2 Visual Resources

The region around the RFETS offers a variety of scenic experiences to users of the area due to the diversity of the topography and geologic formations characteristic of Colorado's Front Range. The RFETS location also provides a scenic view of the Denver metropolitan area. The RFETS and the OU4 area are not considered to have the scenic attributes of the surrounding natural region. The RFETS does not contain distinctive landscape features to distinguish it from adjacent landscapes. The landscape scenic quality for the RFETS is "common" in classification (EG&G, 1992c). Industrial activities at the RFETS have significantly modified the character of the OU4 area.

Colorado State Highways 72, 93, and 128, along with Jefferson County Highway 17, provide the primary views from travel routes. These highways, as well as being the principal transportation routes, are also the dominant human-made features surrounding the RFETS. The numerous structures on the RFETS property constitute the other highly noticeable human-made features in the area.

I.4.9.3 Recreation

There are several recreational areas in the general vicinity of the RFETS including Standley Lake Park, Boulder Mountain Park, Jefferson and Boulder Counties open spaces, and other public lands. Much of the recreational activity involves hiking, climbing, biking, and other opportunities common to large expanses of public land. Hunting and fishing are not allowed in any areas around the RFETS. No recreational activities are allowed within the RFETS boundaries, and public access to the facility is restricted.

I.4.9.4 Transportation

The primary transportation routes through the region are Colorado State Highways 72, 93, 128, and Jefferson County Highway 17. Numerous county and other roads exist in the residential and commercial areas to the north, east, and south of the RFETS. The heaviest traffic volume is on weekdays during the morning and evening rush hours. The 20-year traffic projection for the area north and south of the intersection of State Highways 72 and 93 is 22,000 average daily traffic (ADT), and 20,000 ADT, respectively (DRCOG, 1994).

Access to the RFETS property is attained by turning west from Indiana Avenue onto the East Access Road, or by turning east from Colorado Highway 93 onto the West Access Road (EG&G, 1992c).

Roads that pass through or run adjacent to the OU4 boundaries include an access road to the east and northeast of the SEPs, a paved road south of the SEPs, and a dirt road west of SEP 207-C.

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APPENDIX I.A

SOLAR EVAPORATION POND HISTORY

SOLAR POND HISTORY

October 1953 - Construction of the first clay-lined evaporation pond, Pond 2, was completed (Ryan, E.S., Dow Chemical Company, 1953, *Progress Report - Waste Disposal Unit - October 1953,* Internal Letter to J.G. Epp, Dow Chemical Company, November 6).

December 1953 - Waste was first sent to Pond 2 (Ryan, E.S., Dow Chemical Company, 1953, *Progress Report - Waste Disposal Unit - December 1953,* Internal Letter to J.G. Epp, Dow Chemical Company, January 7).

June 1954 - Leakage from solar pond was first noted based on the existence of a nitrate-contaminated spring on the hillside to the north of the solar pond (Ryan, E.S., Dow Chemical Company, 1954, *Progress Report - Waste Disposal Unit - June 1954,* Internal Letter to H.C. Anderson, Dow Chemical Company, July 8).

November 1954 - A series of tests was initiated to determine whether disposing of contaminated coolant into the solar pond would be practical (Ryan, E.S., Dow Chemical Company, 1954, *Progress Report For the Month of November 1954 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, December 2).

January 1955 - The coolant evaporation study was temporarily discontinued due to increased operation of the coolant still in Building 444 (Ryan, E.S., Dow Chemical Company, 1955, *History Report For the Month of January 1955 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, February 2).

February 1955 - The spring to the north of the solar pond was sampled twice a week; analyses indicated an increasing nitrate concentration (Ryan, E.S., Dow Chemical Company, 1955, *History Report For the Month of February 1955 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, March 2).

April 1955 - Planning began for the replacement of Pond 2 (the original evaporation pond) with two new water tight ponds, each with a capacity of 500,000 gallons (Ryan, E.S., Dow Chemical Company, 1955, *History Report For the Month of April 1955 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, May 2).

May 1955 - RFP personnel become aware that Great Western Reservoir (field trip to Great Western Reservoir on May 4, 1955) was to be used as a drinking water supply; there was concern regarding movement of nitrates offsite from the Solar Pond area. It was decided to build a "water-tight" solar pond (Ryan, E.S., Dow Chemical Company, 1955, *History Report For the Month of May 1955 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, June 1).

June 1955 - Pond 2 required repairs due to liquid appearing south and east of the pond; clay fill was used to prevent seepage (Ryan, E.S., Dow Chemical Company, 1955, *History*

Report For the Month of June 1955 - Waste Disposal Co-Ordination Group, Internal Letter to L.C. Farrell, Dow Chemical Company, July 1).

July 1955 - Construction of Broomfield Heights homes began. This activity made the construction of a water tight pond more of a priority than it was previously (Ryan, E.S., Dow Chemical Company, 1955, *History Report For the Month of July 1955 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, August 1).

August 1955 - Inspection of Pond 2 revealed another leak on the east side of the pond, and that the pond was too full and would soon overflow. It was suggested that, since the proposed water tight ponds were not under construction yet, excavation be made for the construction of a 1-acre clay-lined pond adjacent to the existing evaporation pond (Ryan, E.S., Dow Chemical Company, 1955, *History Report For the Month of August 1955 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, September 1).

September 1955 - A second pond was constructed catty-corner (to the southeast) to Pond 2, due to the lack of capacity in Pond 2. This new pond was designated Pond 2-Auxiliary, and was of earthen construction with no liner whatsoever. Waste only flowed into the pond from a common corner over a weir. Leaks were observed along the east side of new pond during the same month (Ryan, E.S., Dow Chemical Company, 1955, *History Report For the Month of September 1955 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, October 4).

October 1955 - As a result of a lower liquid level in Pond 2, the leaks along the east side of the auxiliary pond subsided (Ryan, E.S., Dow Chemical Company, 1955, *History Report For the Month of October 1955 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, November 3).

December 1955 - Due to wind, water from Pond 2 was blown to the east. A request for soil and vegetation sampling was made from Waste Disposal to Industrial Hygiene (Ryan, E.S., Dow Chemical Company, 1955, *History Report For the Month of December 1955 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, January 4).

January 1956 - Excavation of the first synthetically lined pond (originally designated Pond 2A, later re-designated SEP 207-A) began (Ryan, E.S., Dow Chemical Company, 1956, *History Report For the Month of January 1956 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, February 2).

April 1956 - The subgrade for the water tight pond was completed. Placement of the 3 foot by 14 foot asphalt-impregnated felt planking for the lining began (Ryan, E.S., Dow

Chemical Company, 1956, *History Report For the Month of April 1956 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, May 1).

May 1956 - Placement of the asphalt lining was completed, and the process of sealing the lining began. A request for the necessary piping changes were made. The changes would allow direct transfer of certain waste from Buildings 444 and 881 to the newest evaporation pond. Leaks appeared in the east dike of the original Pond 2 and in the north dike of the auxiliary pond. Clay fill was used to prevent the seepage. It was requested that the auxiliary pond be lined (Ryan, E.S., Dow Chemical Company, 1956, *History Report For the Month of May 1956 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, June 5).

June 1956 - Construction and lining of SEP 207-A was completed. One discharge line had been installed, and another was in the process of being installed. Inspection of the pond revealed that the felt was separated from the asphalt on several sheets. Corrective action was to be taken. It was recommended that test wells be installed around the new pond for analysis of groundwater. The number of seepage leaks from Pond 2 had decreased. It was stated that the auxiliary pond needed clay lining (Ryan, E.S., Dow Chemical Company, 1956, *History Report For the Month of June 1956 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, June 29).

July 1956 - The faulty asphalt sheets were repaired (Ryan, E.S., Dow Chemical Company, 1956, *History Report For the Month of July 1956 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, August 3).

August 1956 - SEP 207-A was placed in limited use (Ryan, E.S., Dow Chemical Company, 1956, *History Report For the Month of August 1956 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, September 5). Ponds 2 and 2-Auxiliary were taken out of service and allowed to dry (Owen, J.B., Dow Chemical Company, 1974, *History of 207 Solar Evaporation Ponds and Nitrate in Walnut Creek*, Letter to E.W. Bean, RFAO, USAEC, April 10).

September 1956 - Dow's approval of the stainless steel pipeline allowed for direct release of liquids to the new pond. Pond 2-Auxiliary was being allowed to dry, and would be clay lined when it was dry (Ryan, E.S., Dow Chemical Company, 1956, *History Report For the Month of September 1956 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, October 2).

October 1956 - Stainless steel extension tubes were attached to the end of the discharge pipes on the new pond, resulting in releases of liquid from 18 inches above the floor. Approximately 2/3 of the pond floor was covered with liquid at this time (Ryan, E.S., Dow Chemical Company, 1956, *History Report For the Month of October 1956 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, November 5).

January 1957 - Lining of Pond 2-Auxiliary with clay began. Samples of the nitrate spring were still being taken (Ryan, E.S., Dow Chemical Company, 1957, *History Report For the Month of January 1957 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, February 4). The "unused pond near 77 Building" was filled for abandonment, due to construction of the asphalt pond (Smith, R.D., Dow Chemical Company, 1957, *Monthly Progress Report - Site Survey - January 1957,* Internal Letter to E.A. Putzier, Dow Chemical Company, February 5).

February 1957 - Lining of the auxiliary pond was completed. Clay was place on the inner face of the east dike of Pond 2, which was dry, to prevent leakage which had developed while the pond was in use (Ryan, E.S., Dow Chemical Company, 1957, *History Report For the Month of February 1957 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, March 4).

March 1957 - Lining of the inner face of the sides of Pond 2 was complete. A wooden spillway was installed below the three discharge pipes, and the pond was returned to service (Ryan, E.S., Dow Chemical Company, 1957, *History Report For the Month of March 1957 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, April 5).

April 1957 - Releases of wastes from Buildings 883 and 774, which were above drinking water tolerance levels, were made to SEP 207-A. Six hundred gallons of salt bath solution were also released to SEP 207-A. Activity build-up in the SEP was being investigated. (Ryan, E.S., Dow Chemical Company, 1957, *History Report For the Month of April 1957 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, May 3).

June 1957 - The study of the activity build-up in SEP 207-A was ongoing. The study was a result of a request from Building 881 for higher release levels (Ryan, E.S., Dow Chemical Company, 1957, *History Report For the Month of June 1957 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, July 5).

July 1957 - Seven drums of contaminated wash water from decontamination of production personnel was disposed of in SEP 207-A. An investigation of possible auxiliary evaporation for SEP 207-A was initiated. The study involved determining an appropriate evaporation booster, such as a tower or spray, to extend the life of the SEP (Ryan, E.S., Dow Chemical Company, 1957, *History Report For the Month of July 1957 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, August 5).

October 1957 - An 8-foot chain link fence was constructed around Pond 2 and SEP 207-A. Studies of the use of clay to reduce activity in the SEP 207-A were initiated (Ryan, E.S., Dow Chemical Company, 1957, *History Report For the Month of October 1957 - Waste*

Disposal Co-Ordination Group, Internal Letter to L.C. Farrell, Dow Chemical Company, November 5).

September 1958 - Aluminum paint was applied to the exposed surface of SEP 207-A to increase evaporation (Ryan, E.S., Dow Chemical Company, 1958, *History Report For the Month of September 1958 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, October 8).

October 1958 - A request for authorization for construction of another asphalt-lined pond was submitted. The second pond was needed in case SEP 207-A ruptured and leaked, and for additional evaporative surface area (Ryan, E.S., Dow Chemical Company, 1958, *History Report For the Month of October 1958 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, November 6).

April 1959 - A third earthen pond was constructed to prevent overflowing of SEP 207-A. Plans for a method to mix Pond 2 liquid with SEP 207-A liquid to enable transfer to Building 995 were being made as another attempt to lower the liquid level in SEP 207-A (Ryan, E.S., Dow Chemical Company, 1959, *History Report For the Month of April 1959 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, May 12). [Note: The new pond was located just east of Pond 2, west of SEP 207-A, and north of Pond 2-Auxiliary. This new pond is believed to have been designated Pond 2D, with 2-Auxiliary being designated 2C.]

May 1959 - Plans for the use of Pond 2 as an oxidation unit using liquids from SEP 207-A were being made (Ryan, E.S., Dow Chemical Company, 1959, *History Report For the Month of May 1959 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, June 8).

June 1959 - Monitoring of the "dumping of alcohol wash from Building 77 into the nitrate pond east of Building 77" was conducted. Following the release, the area above the water line where the wash had been dumped had greater than 100,000 cpm (Hill, J.E., Dow Chemical Company, 1959, *Monthly Progress Report - Site Survey - June 1959*, Internal Letter to E.A. Putzier, Dow Chemical Company, July 6). Various analyses were taken of the pond area, results of which were as follows: 1,040 dpm/l water sample at the nitrate pond; 2 dpm/l water sample at the spring on the north slope of the nitrate pond; and 2.7×10^6 dpm/kg 100 feet east of the nitrate pond (normal soil background was reported to be 2×10^4 to 5×10^4 dpm/kg) (Hammond, S.E., Dow Chemical Company, 1959, *Monthly Progress Report - Site Survey - June 1959*, Internal Letter to T.S. Chapman, Dow Chemical Company, July 6).

July 1959 - The flow pattern of Pond 2 was modified to allow for maximum detention prior to release of the wastes to the sanitary system. The use of Pond 2 as an oxidation pond using liquid from SEP 207-A was initiated (Ryan, E.S., Dow Chemical Company, 1959, *History Report For the Month of July 1959 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, August 10). Monitoring of the sides of the nitrate Pond indicated direct readings of greater than 100,000 cpm and smears up to 300,000 dpm (Hill, J.E., Dow Chemical Company, 1959, *Monthly Progress Report - Site Survey - July 1959,* Internal Letter to E.A. Putzier, Dow Chemical Company, August 3).

August 1959 - The dikes on the east sides of Ponds 2-Auxiliary and 2D were raised to provide additional storage volume. Liquids were transferred to Pond 2 instead of SEP 207-A whenever possible in an effort to lower the volume of SEP 207-A. Water from Pond 2D was pumped to the sanitary system for a period of 7 hours to determine the affect of the liquid on the system. Results were favorable. Another test, with a pumping period of three days, was also conducted (Ryan, E.S., Dow Chemical Company, 1959, *History Report For the Month of August 1959 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, September 9).

September 1959 - The results of the second aforementioned test indicated that the process was unfavorable. Investigation into nitrate reduction methods was conducted using sulfur dioxide gas and air, with unsuccessful results. A study of nitrate reduction using aluminum was initiated (Ryan, E.S., Dow Chemical Company, 1959, *History Report For the Month of September 1959 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, October 7).

October 1959 - It was recommended that the dikes of the ponds be built up for the winter. Bids for construction of the second asphalt-lined pond were sent to ALO for final selection and approval. It was stated that, when the new pond was built, the level of the existing asphalt-lined pond would be lowered to make repairs to planking and sun-checked surface (Ryan, E.S., Dow Chemical Company, 1959, *History Report For the Month of October 1959 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, November 5).

November 1959 - Construction of the second lined SEP began. Wind caused considerable spray of pond water, hindering construction activities (Ryan, E.S., Dow Chemical Company, 1959, *History Report For the Month of November 1959 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, December 10). This solar pond was to consist of three separate cells, and was also constructed of asphalt planking. The designation for this pond was Pond 2B-North, Center, and South, and later changed to SEP 207-B-North, Center, and South. Direct readings of the bank of SEP 2A indicated between 250 and 100,000 cpm. High winds spread salt onto equipment parked east of the pond, but their was no indication of contamination (Hill, J.E., Dow Chemical Company, 1959, *Monthly Progress Report - Site Survey - November 1959,* Internal Letter to E.A. Putzier, Dow Chemical Company, December 3). Samples of the spring on the north slope of the nitrate pond indicated 14 dpm/l (Hammond, S.E., Dow Chemical Company, 1959, *Site Survey Monthly Report - November 1959,* Internal Letter to T.S. Chapman, Dow Chemical Company, December 9).

December 1959 - Seepage noted at the west end of SEP 207-B excavation and a "covered drainage ditch" was constructed to drain the water to the hillside north of the ponds. Samples of the seepage were analyzed daily. The sand and gravel bed was packed in the southern section of the excavation, and a sterilant was applied. The sterilant was then covered with asphalt planking (Ryan, E.S., Dow Chemical Company, 1960, *History Report For the Month of December 1959 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, January 11). [Note: No details on the length or invert elevation of the covered drainage ditch has yet been found on this pipe.] Water samples indicated 84 dpm/l in seepage from the nitrate pond, and 10.5 dpm/l in the spring on the north slope, with enriched uranium being the major component of the activity in the spring water (Hammond, S.E., Dow Chemical Company, 1960, *Monthly Progress Report - Site Survey- December 1959*, Internal Letter to T.S. Chapman, Dow Chemical Company, January 13).

March 1960 - Connecting pipes between the sections of the new asphalt-lined pond, as well as controlling valves, were installed. Cuts in the dike for connecting pipes were backfilled. Construction of the pump station began. Connecting pipes and control valves from the existing pipes to SEP 207-A were installed, completing the pipeline from the new valve pit to the inlet of the new pond. High activity in the effluent, as determined through composite samples from the drainage tile, was attributed to liquids being carried from SEP 207-A by high winds (Ryan, E.S., Dow Chemical Company, 1960, *History Report - Waste Disposal Co-Ordination Group, March 1960,* Internal Letter to L.C. Farrell, Dow Chemical Company, April 11).

April 1960 - Construction activities on the pumping station for the new asphalt-lined pond continued. Placement of planking, as well as mastic application, was completed on the south section. Planking had also been placed in the center and north section, and mastic application had begun. High winds again affected activity levels in the effluent. (Ryan, E.S., Dow Chemical Company, 1960, *History Report - Waste Disposal Co-Ordination Group, April 1960,* Internal Letter to L.C. Farrell, Dow Chemical Company, May 6).

May 1960 - Waste was released into the newly completed cells, SEP 207-B-Center and South (Ryan, E.S., Dow Chemical Company, 1960, *History Report - Waste Disposal Co-Ordination Group, May 1960,* Internal Letter to L.C. Farrell, Dow Chemical Company, June 7). Water samples indicated 2.7 dpm/l at the spring north of the nitrate pond (Hammond, S.E., Dow Chemical Company, 1960, *Monthly Progress Report - Site Survey- May 1960*, Internal Letter to T.S. Chapman, Dow Chemical Company, June 10).

June 1960 - The 207-B SEPs were fully completed. Transfer of water from SEP 207-A was halted when leaks were discovered in the south and center sections. In order to return the liquid to SEP 207-A, it first had to be transferred to the north section, resulting in extensive damage to the north section of the new SEP. The problems were caused by the acidic wastes reacting with the soil and producing gas, which lifted the asphalt planking and ruptured the seams. Investigations into the use of sodium sulfite and sulfur dioxide as reducing agents in high nitrate waste were unsuccessful (Ryan, E.S., Dow Chemical Company, 1960, *History Report - Waste Disposal Co-Ordination Group, June 1960,* Internal Letter to L.C. Farrell, Dow Chemical Company, July 15). Routine use of the earthen ponds, Ponds 2, 2-Auxiliary and 2D, ceases. [NOTE: The only other known discharge to these ponds occurred in March 1963]. Water samples indicated 3.1 dpm/l in the spring north of the nitrate pond (Hammond, S.E., Dow Chemical Company, 1960, *Monthly Progress Report - Site Survey - June 1960*, Internal Letter to T.S. Chapman, Dow Chemical Company, July 11).

July 1960 - All wastes had been transferred from SEPs 207-B North, Central, and South to SEP 207-A. The planking of the 207-B SEPs was cut in some areas in order to relieve the pressure from the gas underneath the planking. A stainless steel flashing was constructed and welded around the connecting pipe between the south and middle sections of the SEP (Ryan, E.S., Dow Chemical Company, 1960, *History Report For the Month of July 1960 - Waste Disposal Co-Ordination Group,* Internal Letter to L.C. Farrell, Dow Chemical Company, August 17). Water samples indicated 4.4 dpm/l in the spring north of the nitrate pond (Hammond, S.E., Dow Chemical Company, 1960, *Monthly Progress Report - Site Survey- July 1960*, Internal Letter to T.S. Chapman, Dow Chemical Company, August 9).

September 1960 - Monitoring of the "three east nitrate ponds" indicated maximum readings of 2,000 cpm direct and 200 dpm removable (Hill, J.E., Dow Chemical Company, 1960, *Monthly Progress Report - Site Survey- September 1960*, Internal Letter to E.A. Putzier, Dow Chemical Company, October 5).

October 1960 - Bids received for relining of the 207-B SEPs were too high. A request for re-bids for lining only the south section was made, and one was accepted (Ryan, E.S., Dow Chemical Company, 1960, *History Report - Waste Disposal Co-Ordination Group October 1960,* Internal Letter to L.C. Farrell, Dow Chemical Company, November 11).

November 1960 - SEP 207-B-South was relined, using asphalt concrete, and seal-coated. The first six groundwater wells were also installed in the immediate vicinity of the 207-B SEPs. (Ryan, E.S., Dow Chemical Company, 1960, *History Report - Waste Disposal Co-Ordination Group - November 1960,* Internal Letter to L.C. Farrell, Dow Chemical Company, December 16).

December 1960 - SEP 207-B South was placed back into service, but was to be used only for treated alkaline wastes from Building 774. Repair of SEPs 207-B Center and North was deferred because of limitations in funding. (Ryan, E.S., Dow Chemical Company, 1960, *History Report - Waste Disposal Co-Ordination Group - December 1960,* Internal Letter to J.G. Epp, Dow Chemical Company, January 26).

January 1961 - The six monitoring wells were sampled for the first time (Ryan, E.S., Dow Chemical Company, 1961, *History Report - Waste Disposal Co-Ordination Group - January 1961,* Internal Letter to J.G. Epp, Dow Chemical Company, February 15).

April 1961 - Preparation for the repair of SEPs 207-B-Center and North began. The center section was drained, and dirt and gravel were removed. The north section was pumped out (Ryan, E.S., Dow Chemical Company, 1961, *History Report - Waste Disposal Co-Ordination Group - April 1961,* Internal Letter to J.G. Epp, Dow Chemical Company, May 19). Work activities at this time included the construction of a drainage tile immediately east of the SEPs to intercept any leakage flowing to the east. Underdrains in the SEPs themselves were not constructed. The asphalt concrete was place over the asphalt planking except in SEP 207-B-North, where difficulties were encountered and the planking was removed. Concern was centered on SEP 207-A, which was believed to be leaking.

June 1961 - Cleaning and draining of SEP 207-B-Center and North in preparation for repair was completed (Ryan, E.S., Dow Chemical Company, 1961, *History Report - Waste Disposal Co-Ordination Group - June 1961,* Internal Letter to J.G. Epp, Dow Chemical Company, July 11).

July 1961 - Repair on SEPs 207-B-Center and North began. Because of difficulty in laying the asphalt concrete over the asphalt planking, the planking was removed in the north section. A rupture occurred in the asphalt concrete in the south section of the SEP, near the outlet from Building 774. Pumping was transferred to SEP 207-A so that repairs could be made (Ryan, E.S., Dow Chemical Company, 1961, *History Report - Waste Disposal Co-Ordination Group - July 1961,* Internal Letter to J.G. Epp, Dow Chemical Company, August 18).

August 1961 - SEPs 207-B-Center and North were returned to service. The contents of the south section were transferred to the center section, and were mixed with sodium silicate as they passed through the transfer pipe. The three sections were then equalized, and spill boxes were installed at the ends of the discharge pipes. The north section was then closed off for use in spray evaporation studies (Ryan, E.S., Dow Chemical Company, 1961, *History Report - Waste Disposal Co-Ordination Group - August 1961,* Internal Letter to J.G. Epp, Dow Chemical Company, September 26).

October 1961 - Prior to spraying operations at the nitrate pond, background surface readings and soil samples were taken. Air samples taken during spraying indicated very little airborne activity (Hill, J.E., Dow Chemical Company, 1961, *Monthly Progress Report - Site Survey- October 1961*, Internal Letter to E.A. Putzier, Dow Chemical Company, November 6).

February 1962 - The pipeline between SEPs 207-B Center and North was reopened to allow transfer. Spray evaporation had not yet been attempted, and the line would be closed when the study began (Ryan, E.S., Dow Chemical Company, 1961, *History Report - Process Waste Disposal Group, February 1962,* Internal Letter to G.E. White, Dow Chemical Company, March 20).

March 1962 - During routine inspection of SEP 207-A, several breaks in the asphalt planking were discovered. Liquid was transferred to the 207-B SEPs using a large portable pump. This was the first transfer using the pump from SEP 207-A to the 207-B SEPs. It was also discovered at this time that liquid was leaking beneath the planking, seeping into the drainage tile, and being mixed with water in Pond 2 (Ryan, E.S., Dow Chemical Company, 1962, *History Report - Process Waste Disposal Group, March 1962,* Internal Letter to G.E. White, Dow Chemical Company, April 18). Silicate was going to be applied to the soil beneath the leak in the planking; however, as of May 10, 1962, this had not yet been done (Ryan, E.S., Dow Chemical Company, 1962, *History Report - Process Waste Disposal Group, April 1962,* Internal Letter to G.E. White, Dow Chemical Company, May 10).

July 1962 - Water samples indicated 1.8 microcuries per liter in the spring on the northeast slope of the nitrate pond (Ray, E.L., Dow Chemical Company, 1962, *Monthly Progress Report - Site Survey- July 1962*, Internal Letter to C.W. Piltingsgrud, Dow Chemical Company, August 9).

September 1962 - Work on the removal of Pond 2-Auxiliary begins due to the anticipated construction of Building 779, some of which will be over Pond 2-Auxiliary. The floor of the clay-lined pond was monitored prior to the arrival of construction personnel, with results of up to 5,000 cpm. Waste disposal analyses of soil indicated 11,000 to 75,000 dpm/kg. It was recommended that the soil be removed prior to construction activities (Hill, J.E., Dow Chemical Company, 1962, *Monthly Progress Report - Site Survey - Industrial Hygiene - September 1962*, Internal Letter to E.A. Putzier, Dow Chemical Company, October 2).

October 1962 - The clay lining was removed from Pond 2-Auxiliary. Monitoring indicated low surface contamination (Hill, J.E., Dow Chemical Company, 1962, *Monthly Progress Report - Site Survey- Industrial Hygiene - October 1962*, Internal Letter to E.A. Putzier, Dow Chemical Company, November 5).

November 1962 - Monitoring of the "large nitrate pond" indicated 500 to 1,000 cpm direct on the exposed surfaces. Analyses of the salt indicated 1,500 to 2,000 dpm/g. Rebuilding of this pond was pending (Hill, J.E., Dow Chemical Company, 1962, *Monthly Progress Report - Site Survey - Industrial Hygiene - November 1962*, Internal Letter to E.A. Putzier, Dow Chemical Company, December 3).

February 1963 - Small cracks were discovered in the asphalt concrete of the 207-B SEPs. [NOTE: Specific section not mentioned.] (Ryan, E.S., Dow Chemical Company, 1963, *History Report - Process Waste Disposal Group - February 1963,* Internal Letter to G.E. White, Dow Chemical Company, March 14).

March 1963 - Only known post-June 1960 discharge to the earthen ponds: Ponds 2,2-Auxiliary and 2D.

April 1963 - Relining work on SEP 207-A begins with the removal of salts and cleaning of exposed lining. (Ryan, E.S., Dow Chemical Company, 1963, *History Report - Process Waste Disposal Group - April 1963,* Internal Letter to G.E. White, Dow Chemical Company, May 20).

May 1963 - The content of SEP 207-B-North was pumped as low as possible, and cracks in the sides of the SEP were sealed. Forty drums of contaminated aluminum scrap were dumped in SEP 207-A. Laboratory studies of evaporation were conducted for development of an evaporation unit for high nitrate aqueous wastes. (Ryan, E.S., Dow Chemical Company, 1963, *History Report - Process Waste Disposal Group, May 1963,* Internal Letter to G.E. White, Dow Chemical Company, June 17).

June 1963 - Transfer of SEP 207-A contents to the 207-B SEPs with an addition of caustic began. Three trailer loads of caustic were added to the 207-B SEPs, and five trailer loads were added to SEP 207-A. (Ryan, E.S., Dow Chemical Company, 1963, *History Report - Process Waste Disposal Group, June 1963,* Internal Letter to G.E. White, Dow Chemical Company, July 30).

July 1963 - The transfer of liquids from SEP 207-A to the 207-B SEPs was completed. A small heel of remaining acid waste was neutralized by pumping basic wastes from SEP 207-B-South to SEP 207-A, and then from SEP 207-A to SEP 207-B-North. A test of the burning capabilities of the SEP 207-A lining was made to evaluate it as a method of disposal. The planking was not combustible alone, and required fuel for burning. (Ryan, E.S., Dow Chemical Company, 1963, *History Report - Process Waste Disposal Group, July 1963,* Internal Letter to G.E. White, Dow Chemical Company, August 19).

August 1963 - Removal of plank lining and sand sub-grade from SEP 207-A began. (Ryan, E.S., Dow Chemical Company, 1963, History Report - Process Waste Disposal Group - *August 1963,* Internal Letter to G.E. White, Dow Chemical Company, September 19). Vegetation samples taken from the southwest corner of the "main nitrate pond" indicated 960 dpm/kg (Hammond, S.E., Dow Chemical Company, 1963, *Monthly Progress Report - Site Survey - August 1963*, Internal Letter to C.W. Piltingsrud, Dow Chemical Company, September 9).

September 1963 - Removal of asphalt planking and excavation work for SEP 207-A re-design was completed. (Ryan, E.S., Dow Chemical Company, 1963, *History Report - Process Waste Disposal Group, September 1963,* Internal Letter to G.E. White, Dow Chemical Company, October 16). The planking was disposed of in Trench T-4. The planking contained approximately 16.2 grams of uranium (Frieberg, K.J., Dow Chemical Company, 1973, *Monthly Status Report - Health Physics Operations, Technical and Construction - November 1973,* Internal letter to E.A. Putzier, Dow Chemical Company, December 4). Vegetation samples taken from the northeast corner of the nitrate pond indicated 310 dpm/kg (Hammond, S.E., Dow Chemical Company, 1963, *Monthly Progress Report - Site Survey - September 1963*, Internal Letter to C.W. Piltingsrud, Dow Chemical Company, October 15).

October 1963 - Relining and reforming of SEP 207-A began. The SEP was to be lined with two asphalt concrete mats (Ryan, E.S., Dow Chemical Company, 1963, *History Report - Process Waste Disposal Group - October 1963*, Internal Letter to G.E. White, Dow Chemical Company, November 14).

November 1963 - The modification of SEP 207-A was completed (Ryan, E.S., Dow Chemical Company, 1963, *History Report - Process Waste Disposal Group - November 1963,* Internal Letter to G.E. White, Dow Chemical Company, December 16).

January 1964 - The process waste lines to the asphalt SEPs were relocated. This was necessary because of the construction of Building 779 (Ryan, E.S., Dow Chemical Company, 1964, *History Report - Process Waste Disposal Group - January 1964*, Internal Letter to G.E. White, Dow Chemical Company, February 13).

March 1964 - Extensions of the SEP 207-A discharge pipes were installed, as was a trough from the extensions to the bottom of the SEP (Ryan, E.S., Dow Chemical Company, 1964, *History Report - Process Waste Disposal Group - March 1964*, Internal Letter to G.E. White, Dow Chemical Company, April 15).

April 1964 - The coupling of a 1,600 gpm pump at SEP 207-A was completed (Ryan, E.S., Dow Chemical Company, 1964, *History Report - Process Waste Disposal Group - April 1964*, Internal Letter to G.E. White, Dow Chemical Company, May 18).

May 1964 - Transfer of wastes from SEP 207-B-North to SEP 207-A was made (Ryan, E.S., Dow Chemical Company, 1964, *History Report - Process Waste Disposal Group - May 1964*, Internal Letter to G.E. White, Dow Chemical Company, June 17).

June 1964 - Wastes were transferred from SEPs 207-B-North and Center to SEP 207-A. The exposed portions of the 207-B SEPs were inspected (Ryan, E.S., Dow Chemical Company, 1964, *History Report - Process Waste Disposal Group - June 1964*, Internal Letter to G.E. White, Down Chemical Company, July 29).

July 1964 - Vegetation samples taken from the southwestern corner of the west nitrate pond indicate 2,800 dpm/kg (Hammond, S.E., Dow Chemical Company, 1964, *Monthly Progress Report - Site Survey - July 1964*, Internal Letter to C.W. Piltingsrud, August 5).

August 1964 - Vegetation samples taken from the northeastern corner of the east nitrate pond indicate 4,500 dpm/kg (Hammond, S.E., Dow Chemical Company, 1964, *Monthly Progress Report - Site Survey - August 1964*, Internal Letter to C.W. Piltingsrud, September 8).

September 1964 - A pilot plant evaporator was placed on-line. Trial runs using domestic water were conducted, to be followed by trial runs using SEP 207-A water (Ryan, E.S., Dow Chemical Company, 1964, *History Report - Process Waste Disposal Group - September 1964*, Internal Letter to G.E. White, Dow Chemical Company, October 26). Vegetation samples indicate 180 dpm/kg at the southwestern corner of the west nitrate pond, and 1,000 dpm/kg east of the southern edge of the nitrate ponds (Hammond, S.E., Dow Chemical Company, 1964, *Monthly Progress Report - Site Survey - September 1964*, Internal Letter to C.W. Piltingsrud, October 12).

October 1964 - The sides of SEPs 207-B-North and Center were patched using cold patch mastic. Wastes were being pumped to SEP 207-A (Ryan, E.S., Dow Chemical Company, 1964, *History Report - Process Waste Disposal Group - October 1964*, Internal Letter to G.E. White, Dow Chemical Company, November 16). The sides of SEP 207-B-South had not yet been repaired (Ryan, E.S. Dow Chemical Company, 1964, *History Report - Process Waste Disposal Group - November 1964*, Internal Letter to G.E. White, Dow Chemical Company, December 26).

December 1966 - Releases of low nitrate treated wastes from Building 774 were impounded in the asphalt-lined evaporation SEPs so that effluent from Building 995 could be used to dilute the nitrates (Ryan, E.S., Dow Chemical Company, 1967, *Status Report - Waste Disposal Coordination - December 1966*, Internal Letter to E.A. Putzier, Dow Chemical Company, January 10).

April 1967 - An unsuccessful attempt was made to fill the cracks on the side walls of SEP 207-B North with asphalt mastic.

November 1967 - Twenty-five thousand gallons of waste were taken from SEP 207-A and disposed of in the evaporator. SEP 207-B-North was repaired, and was expected to be in service in December (Maas, M.E., Dow Chemical Company, 1967, *Progress Report for November*, Internal Letter to K.V. Best, Dow Chemical Company, November 27).

1968-1970 - Lithium scrap was disposed of on the dikes between the evaporation SEPs by spraying it with water.

February 1968 - A Fire Department pumper truck was used to spread 250 pounds of "Nigrosine 12525 Acid Black 2" dye into SEPs 207-A and the 207-B SEPs in an attempt to increase the evaporation rates. An extra 250 pounds were reserved for later use (Maas, M.E., Dow Chemical Company, 1968, *Progress Report for February*, Internal Letter to K.V. Best, Dow Chemical Company, February 27).

April 1968 - All wastes were transferred to the 207-B SEPs. SEP 207-A was dormant (Maas, M.E., Dow Chemical Company, 1968, *Progress Report for February*, Internal Letter to K.V. Best, Dow Chemical Company, February 27).

October 1968 - Repairs were made to cracked side walls in SEP 207-B-Center with burlap and asphalt. An additional coat of asphalt was also applied to SEP 207-B-North (Owen, J.B., Dow Chemical Company, 1974, *History of 207 Solar Evaporation Ponds and Nitrate in Walnut Creek*, Letter to E.W. Bean, RFAO, USAEC, April 10).

January 1969 - Low-level contamination and salts were blown out and to the east of the SEPs by high winds (Piltingsrud, C.W., 1969, *Status Report - Health Physics - January 1969,* February 12).

June 1969 - Leakage appeared on the ground surface at the northeastern corner of the 207-B SEPs, possibly due to a previous leak in the northern and center sections of the pond, which was repaired in 1967. Plans were made to transfer the contents of SEP 207-B-North and Center to SEP 207-A and repair the northern and center sections (Maas, M.E., Dow Chemical Company, 1969, *Monthly Progress Report - Waste Treatment - June*, Internal Letter to L.F. Grill, Dow Chemical Company, July 3).

August 1969 - SEP 207-B-North was emptied. Burlap was placed in uncovered areas and a coat of asphalt was applied. Another coat of asphalt was to be applied to old and new burlap surfaces by the following month, at which time SEP 207-B-North would be returned to service and SEP 207-B-Center would be repaired (Maas, M.E., Dow Chemical Company, 1969, *Monthly Progress Report - Waste Treatment - August*, Internal Letter to L.F. Grill, Dow Chemical Company, September 4).

September 1969 - A second coat of asphalt was applied to SEP 207-B-North, completing repair. The contents of SEP 207-B-Center were transferred to the northern section and then to SEP 207-A. Burlap and a coat of asphalt were placed in the center section, and a second coat was to be applied the following month (Maas, M.E., Dow Chemical Company, 1969, *Monthly Progress Report - Waste Treatment - September*, Internal Letter to L.F. Grill, Dow Chemical Company, October 7).

1970 - Pond 2 and Pond 2D areas were regraded in 1970 to accommodate construction of SEP 207-C. The soils and dikes from these ponds may have been used in the construction of SEP 207-C.

April 1970 - Catch sumps and pumps were installed to return water from the drain tiles to the SEPs. Sump No. 1, located at the north end of the drainage tile east of the 207-B SEPs, returned water to SEP 207-B-North. Sump No. 2, located at the northern end of the drainage tile between SEP 207-A and the 207-B SEPs, returned water to SEP 207-A (Owen, J.B., Dow Chemical Company, 1974, *History of 207 Solar Evaporation Ponds and Nitrate in Walnut Creek*, Letter to E.W. Bean, RFAO, USAEC, April 10).

May 1970 - A soaker hose and pump were installed at the east berm of SEP 207-A as an attempt to increase evaporation rates. The new installations would allow water to trickle over the berm. Construction of SEP 207C, a new asphalt-lined pond, began. The SEP was to be used to store liquids during repair of the existing SEPs (Maas, M.E., Dow Chemical Company, 1970, *Monthly Progress Report - Waste Treatment - May*, Internal Letter to L.F. Grill, Dow Chemical Company, June 10).

June 1970 - SEP 207-B-South was emptied for relining (Maas, M.E., Dow Chemical Company, 1970, *Building 774 - June, July Progress Report*, August 5). SEP 207C was under construction west of SEP 207-A. The "small south nitrate pond" was leaking and thought to be the cause of high nitrate concentrations in North Walnut Creek (Fretberg, K.J., Dow Chemical Company, 1970, *Health Physics Monthly Status Report - Operations Group Technical and Construction - June 1970*, Internal Letter to E.A. Putzier, July 9).

August 1970 - A program to eliminate the use of the SEPs was initiated and submitted to AEC (Freiberg, K.J., Dow Chemical Company, 1970, *Health Physics Monthly Status Report - Operations Group Technical and Construction - August 1970*, Internal Letter to E.A. Putzier, September 9).

September 1970 - All side walls of SEP 207-B-South had been covered with burlap and asphalt (Owen, J.B., Dow Chemical Company, 1974, *History of 207 Solar Evaporation SEPs and Nitrate in Walnut Creek*, Letter to E.W. Bean, RFAO, USAEC, April 10). Paving and earthwork at SEP 207C was completed. Ground water was seeping into the sump, and this problem was to be resolved prior to sealing the area. Sludge was expected to be removed using liquid from existing SEPs to create a slurry which could be pumped, rather than direct removal (Fretberg, K.J., Dow Chemical Company, 1970, *Health Physics Monthly Status Report - Operations Group Technical and Construction - September 1970*, Internal Letter to E.A. Putzier, Dow Chemical Company, October 8).

December 1970 - SEP 207C was placed in service (Owen, J.B., Dow Chemical Company, 1974, *History of 207 Solar Evaporation Ponds and Nitrate in Walnut Creek*, Letter to E.W. Bean, RFAO, USAEC, April 10).

May 1971 - Test holes were dug and water samples were taken at the location of Trenches 1 and 2 (Owen, J.B., Dow Chemical Company, 1974, *History of 207 Solar Evaporation Ponds and Nitrate in Walnut Creek*, Letter to E.W. Bean, RFAO, USAEC, April 10). Sediment samples taken from the 207-B SEPs indicated up to 10,000 dpm/g uranium and up to 140,000 dpm/g plutonium (Piltingsrud, C.W., 1971, *Status Report - Health Physics - May 1971*, Internal Letter to W.H. Lee, June 10). Direct readings indicated 25,000 cpm. Work using a bulldozer to remove the silt was planned for the area (Fretberg, K.J., Dow Chemical Company, 1971, *Health Physics Monthly Status Report - Operations Group Technical and Construction - May 1971*, Internal Letter to E.A. Putzier, June 9).

August 1971 - Soaker hoses were installed around the perimeter of SEPs 207-A and 207C (Owen, J.B., Dow Chemical Company, 1974, *History of 207 Solar Evaporation Ponds and Nitrate in Walnut Creek*, Letter to E.W. Bean, RFAO, USAEC, April 10). Sludge removal operations were occurring at the evaporation SEPs (specific pond not indicated) (Piltingstrud, C.W., 1971, *Status Report - Health Physics - July 1971*, Internal Letter to J.F. Willging, August 10).

October 1971 - All side walls of SEPs 207-B-North and Center were covered with Petromat® liner and a hydraulic sealant. Trenches 1 and 2 were dug (Owen, J.B., Dow Chemical Company, 1974, *History of 207 Solar Evaporation Ponds and Nitrate in Walnut Creek*, Letter to E.W. Bean, RFAO, USAEC, April 10). Liquid collected in Trenches 1 and 2 went to Sumps 1 and 2, and then to SEPs 207-B-North and 207-A, respectively (Rockwell International, 1988, *Solar Evaporation Ponds Closure Plan*, July 1).

November 1971 - SEP 207-B-South was being cleaned (Putzier, E.A., 1971, *Status Report - Health Physics Operations Input to Operations - December 1971*, Internal Letter to J.F. Willging, January 7).

May 1972 - Automatic pump controls were installed in Trenches 1 and 2 (Owen, J.B., Dow Chemical Company, 1974, *History of 207 Solar Evaporation Ponds and Nitrate in Walnut Creek,* Letter to E.W. Bean, RFAO, USAEC, April 10).

September 1972 - Trench 3 was placed in service (Owen, J.B., Dow Chemical Company, 1974, *History of 207 Solar Evaporation Ponds and Nitrate in Walnut Creek*, Letter to E.W. Bean, RFAO, USAEC, April 10). Liquid collected in Trench 3 was transferred to SEP 207-A (Rockwell International, 1988, *Solar Evaporation Ponds Closure Plan*, July 1).

October 1972 - The side walls and bottom of SEP 207-B-South were relined with Petromat® and a hydraulic sealant (Owen, J.B., Dow Chemical Company, 1974, *History of 207 Solar Evaporation Ponds and Nitrate in Walnut Creek*, Letter to E.W. Bean, RFAO, USAEC, April 10).

January 1973 - The "nitrate capture trenches located on the hillside north of the process waste holding ponds" were in operation. Water from the trenches was being analyzed and returned to the ponds. Three trenches existed at this time (Maas, M.E., and D.E. Michels, 1973, *Monthly Environmental Progress Report - Removal of Nitrate from Soil*, February).

April 1973 - Six to ten tons of nitrate leached from the soils north of the SEPs due to high water flows (Maas, M.E., and D.E. Michels, 1973, *Monthly Environmental Progress Report - Removal of Nitrate from Soil*, May).

May 1973 - The trench pumps were turned off because of overloading of the evaporation SEPs due to rain (Maas, M.E., and D.E. Michels, 1973, *Monthly Environmental Progress Report - Removal of Nitrate from Soil*, June).

September 1973 - The side walls and bottom of SEP 207-B-North were relined with a Petromat liner and a hydraulic sealant (Owen, J.B., Dow Chemical Company, 1974, *History of 207 Solar Evaporation Ponds and Nitrate in Walnut Creek*, Letter to E.W. Bean, RFAO, USAEC, April 10).

April 1974 - Trenches 4 and 5 were placed in service (Owen, J.B., Dow Chemical Company, 1974, *History of 207 Solar Evaporation Ponds and Nitrate in Walnut Creek*, Letter to E.W. Bean, RFAO, USAEC, April 10). Liquid collected in Trench 5 was transferred to Trench 4, and liquid collected in Trench 4 was transferred to Trench 3 (Rockwell International, 1988, *Solar Evaporation Ponds Closure Plan*, July 1).

June 1974 - The Petromat® liner of SEP 207-B-North was considered to be a problem. Actions were being taken to reline the pond bottom with asphalt concrete three inches thick. A pond leakage study was conducted using Rhodamine WT dye (Thompson, M.A., 1974, *Progress Report for June 1974 - Environmental Sciences and Waste Control*, Internal Letter to H.E. Bowman, July 12).

July 1974 - Trench 6 was placed in service. Liquid collected in the trench was transferred to SEP 207-A (*Evaporator Notes & SEPs Record*, 1978, Handwritten Logbook, Entry of July 8. Rockwell International, 1988, *Solar Evaporation Ponds Closure Plan*, July 1). Also completed in July was a study to provide for 100 percent recycle of RFP waters. This study recommended the use of SEP 207-A and the 207-B SEPs for storage of water treated through the reverse osmosis system and for storage of treated sanitary effluent awaiting treatment in the reverse osmosis system (Engineering-Science, Inc., 1974, An Engineering Study for Water Control and Recycle, Prepared for the Rocky Flats Area Office of the U.S. Atomic Energy Commission, July 21). Future activities related to cleanout and relining of the 207-B SEPs were partly in support of this water recycle project. Following the publishing of this study, the 207-B SEPs were cleaned out and no further process wastes were placed in the 207-B SEPs.

September 1974 - An in-depth study including core drilling and soil analysis was initiated. An inventory and maps of nitrate deposits were to be prepared (Illsley, C.T., 1974, *Monthly Environmental Progress Report*, Report for September 1974, October).

October 1974 - An inventory of nitrate deposits northeast of the SEPs was in progress (Illsley, C.T., 1974, *Monthly Environmental Progress Report*, Report for October 1974, November).

November 1974 - A report of the nitrate inventory in the soil north of the SEPs was written (Illsley, C.T., 1974, *Monthly Environmental Progress Report*, Report for November 1974, December).

March 1975 - Low level alpha contamination was detected around the perimeter of the SEPs. It was believed to be caused by the operation of the soaker hose system on the berm of SEP 207-A. Soil contamination was also detected on the downwind side of SEP 207-A (Thompson, M.A., 1975, *Progress Report for March 1975 - Environmental Sciences and Waste Control*, Internal Letter to H.E. Bowman, April 10).

September 1975 - Cleanout and repair of SEP 207-B-North was completed (Kittinger, W.D., Rockwell International, 1975, *Radiation Monitoring - Monthly Report - September, 1975*, Internal Letter to E.A. Putzier, Rockwell International, October 10).

April 1976 - Core samples were taken from the SEPs for the water recycle project (results of the samples were not indicated) (Hornbacher, D.D., Rockwell International, 1976, *Environmental Control Weekly Highlights Week Ending April 9, 1976*, Internal Letter to M.A. Thompson, Rockwell International, April 9).

Late August or September 1976 - An unsuccessful trial run was conducted on cleanup of the 207-B SEPs. Contamination was found on and under the liner and in nearby soil. It was thought that an environmental enclosure would be necessary for cleanup activities (Hornbacher, D.D., Rockwell International, 1976, *Environmental Analysis and Control Weekly Highlights Week Ending September 3, 1976*, Internal Letter to M.A. Thompson, Rockwell International, September 3). Air monitoring during SEP cleanup indicated between 0.00102 and 0.17136 pCi/m^3 plutonium concentration (Hornbacher, D.D., Rockwell International, 1976, *Environmental Analysis and Control Weekly Highlights Week Ending October 8, 1976*, Internal Letter to Environmental Sciences, October 8).

October 1976 - Eleven core samples were taken from the SEP area in preparation for the reverse osmosis holding ponds (Hornbacher, D.D., Rockwell International, 1976, *Environmental Analysis and Control Weekly Highlights Week Ending October 22, 1976*, Internal Letter to Environmental Sciences, October 22). Fifteen soil samples were also taken during the month to determine contamination levels (Hornbacher, D.D., Rockwell International, 1976, *Environmental Analysis and Control Weekly Highlights Week Ending October 29, 1976*, Internal Letter to Environmental Sciences, October 29). Air Samples taken during SEP cleanup during the first half of the month indicated plutonium concentrations ranging from 0.00395 to 0.86791 pCi/m^3 (Hornbacher, D.D., Rockwell International, 1976, *Environmental Analysis and Control Weekly Highlights Week Ending November 5, 1976*, Internal Letter to M.V. Werkema, Rockwell International, November 5).

November 1976 - A "crash program" of sampling and direct counting was initiated, providing aid for the completion of the design criteria for the project. The program consisted of coring through the liner and augering into the deeper soil (Hornbacher, D.D., Rockwell International, 1976, *Environmental Analysis and Control Weekly Highlights Week Ending November 5, 1976*, Internal Letter to M.V. Werkema, Rockwell International, November 5).

February 1977 - The liner of SEP 207-B-North was damaged by high winds, resulting in increased airborne total long-lived alpha concentrations. Water was put in the pond to keep the liner in place (Hornbacher, D.D., Rockwell International, 1977, *Environmental Analysis and Control Weekly Highlights Week Ending February 4, 1977*, Internal Letter to M.V. Werkema, Rockwell International, February 4). The southeastern perimeter of SEP 207-C was sandbagged to prevent spillage due to high winds. The liner of SEP 207-B-North was weighted down with steel pellets to prevent flotation (Hornbacher, D.D., Rockwell International, 1977, *Environmental Analysis and Control Weekly Highlights Week Ending February 18, 1977*, Internal Letter to M.V. Werkema, Rockwell International, February 18; Hornbacher, D.D., Rockwell International, 1977, "Environmental Analysis and Control Weekly Highlights Week Ending February 25, 1977," Internal Letter to M.V. Werkema, Rockwell International, February 25).

March 1977 - A recommendation for disposal of 50 liters of toluene containing 20 microcuries of tritium into SEP 207-A was made (Hornbacher, D.D., Rockwell International, 1977, *Environmental Analysis and Control Highlights - Week Ending April 1, 1977*, Internal Letter to M.V. Werkema, Rockwell International, April 1).

June 1977 - Gravel removal at the SEP area began. (This may have begun in late May 1977.) Survey of the area during removal operations indicated a high reading of 15,000 cpm (Hornbacher, D.D., Rockwell International, 1977, *Environmental Analysis and Control Weekly Highlights Week Ending June 3, 1977*, Internal Letter to M.V. Werkema, Rockwell International, June 3). A map indicating contamination levels in the vicinity of the SEPs was prepared (Hornbacher, D.D., Rockwell International, 1977, *Environmental Analysis and Control Weekly Highlights Week Ending June 10, 1977*, Internal Letter to M.V. Werkema, Rockwell International, June 10). Soil removal operations were conducted in the Building 910 storage yard and along the fence between the SEPs and the yard using a portable building for manual removal, or a front end loader with a dust suppressant. Air sampling during the activities indicated 0.005 to approximately 0.3 pCi/m^3. Construction of the reverse osmosis building began during this month (Hornbacher, D.D., Rockwell International, 1977, *Environmental Analysis and Control Weekly Highlights Week Ending June 24, 1977*, Internal Letter to M.V. Werkema, Rockwell International, June 24).

July 1977 - Soil was removed from an area south of SEP 207-A using a road grader and front end loader (Hornbacher, D.D., Rockwell International, 1977, *Environmental Analysis* *and Control Weekly Highlights Week Ending July 29, 1977*, Internal Letter to M.V. Werkema, Rockwell International, July 29).

August 1977 - Activities at SEP 207-B-South included water removal, cleaning, and sludge removal. The pellets which had been placed in SEP 207-B-North were removed, and cleaning also began at the SEP (Author Unknown, 1977?, *Pond Clean-Up Operations*, Chronology of Pond Clean-Up Activities from August 17, 1977 to September 2, 1977, Date Unknown).

Late August or September 1977 - An increase in airborne alpha activity was reported during soil removal activities at the SEPs (Hornbacher, D.D., Rockwell International, 1977, *Environmental Analysis and Control Weekly Highlights Week Ending September 2, 1977*, Internal Letter to M.V. Werkema, Rockwell International, September 2). Air monitoring on September 19 indicated 0.095 pCi/m^3 total long-lived alpha (Hornbacher, D.D., Rockwell International, 1977, *Environmental Analysis and Control Weekly Highlights Week Ending September 23, 1977*, Internal Letter to M.V. Werkema, Rockwell International, September 23). Near the end of the month, air sampling results exceeded the shutdown action level. Cleanup of SEP 207-B-North was completed (Hornbacher, D.D., Rockwell International, 1977, *Environmental Analysis and Control Weekly Highlights Week Ending September 30, 1977*, Internal Letter to M.V. Werkema, Rockwell International, September 30). The water and liner were removed from Pond 207-B-North, and cleaning of the SEP continued (Author Unknown, 1977?, *Pond Clean-Up Operations*, Chronology of Pond Clean-Up Activities from August 17, 1977 to September 2, 1977, Date Unknown).

October 1977 - The highest total long-lived alpha concentration since cleanup activities began, 0.951 pCi/m^3, was measured near a shipping box which was being loaded with soil (Hornbacher, D.D., Rockwell International, 1977, *Environmental Analysis and Control Weekly Highlights Week Ending October 7, 1977*, Internal Letter to M.V. Werkema, Rockwell International, October 7). Removal of soil between SEP 207-A and the SEP 207-B was completed. Removal of soil south of 207-B SEPs began (Hornbacher, D.D., Rockwell International, 1977, *Environmental Analysis and Control Weekly Highlights Week Ending October 17, 1977*, Internal Letter to M.V. Werkema, Rockwell International, October 17). High results during air monitoring were again a problem. Sprinkling over a longer period of time, rather than flooding the area, was recommended, as well as the use of Coherex® stabilizer (Hornbacher, D.D., Rockwell International, 1977, *Environmental Analysis and Control Weekly Highlights Week Ending October 21, 1977*, Internal Letter to M.V. Werkema, Rockwell International, October 21).

March 1978 - Alternate uses of water from the reverse osmosis building and sewage treatment plant were being considered. A proposal for a new pond on the western side of the plant was rejected. The use of spray irrigation was being evaluated (Hornbacher, D.D., Rockwell International, 1978. *Environmental Analysis and Control Weekly Highlights*

Week Ending March 23, 1978, Internal Letter to M.V. Werkema, Rockwell International, May 26).

May 1978 - Petromat® from the 207-B SEPs were removed and boxed. The asphalt concrete liners were not removed. High airborne total long-lived alpha activity was an ongoing problem (Hornbacher, D.D., Rockwell International, 1978, *Environmental Analysis and Control Weekly Highlights Week Ending May 26, 1978*, Internal Letter to M.V. Werkema, Rockwell International, May 26).

July 1978 - Residual uranium and americium were found in the equalizer between SEPs 207-B-Center and 207-B-South. The line was cleaned with acid (Hornbacher, D.D., Rockwell International, 1978, *Environmental Analysis and Control Weekly Highlights Week Ending May 26, 1978*, Internal Letter to M.V. Werkema, Rockwell International, July 28).

August 1978 - Lining of SEP 207-B-South was near completion (Hornbacher, D.D., Rockwell International, 1978, *Environmental Analysis and Control Weekly Highlights Week Ending August 4, 1978*, Internal Letter to M.V. Werkema, Rockwell International, August 4).

January 1979 - Plutonium values of 5.8 to 12.6 pCi/l were detected in SEP 207-B-North. This was due to the transfer of sodium hydroxide spillwater from Basin B-1 to SEP 207-B-North (Barker, C.J., Rockwell International, 1979, *Highlights for Week Ending January 19, 1979 Environmental Analysis and Control*, Internal Letter to M.V. Werkema, Rockwell International, January 19).

April 1979 - Release of the caustic spill water in SEP 207-B-North into Basins B-2 and A-2 began (Hornbacher, D.D., Rockwell International, 1979, *Highlights for Week Ending April 27, 1979, Environmental Analysis and Control,* Internal Letter to M.V. Werkema, Rockwell International, April 27). Plans to run the spill water through the reverse osmosis plant or process it through the sewage treatment plant were not implemented.

May 1980 - Water bubbles appeared under the liner of SEP 207-B-South (Hornbacher, D.D., Rockwell International, 1980, *Environmental Analysis Weekly Highlights Week Ending May 16, 1980*, Internal Letter to T.R. Crities, Rockwell International, May 16). The SEP had been used for storage of sanitary water prior to reverse osmosis treatment, but was drained and cleaned for storage of reverse osmosis treated water for use in the plant's cooling towers. A survey of the liner indicated no smear count, but 50,000 to 500,000 cpm on the western side wall behind the liner, possibly resulting from leakage from SEP 207-A. The discovery of leakage delayed approval of use of the water in the plant's cooling towers for fear of contamination (Hornbacher, D.D., Rockwell International, 1980, *Environmental Analysis Weekly Highlights Week Ending May 30, 1980*, Internal Letter to T.R. Crites, Rockwell International, May 30).

June 1980 - The source of activity beneath the liner on the western wall of Pond 207-B-South was determined to be americium (Hornbacher, D.D., Rockwell International, 1980, *Environmental Analysis Weekly Highlights Week Ending June 6, 1980*, Internal Letter to T.R. Crites, Rockwell International, June 6).

July 1980 - Salts on the side walls of SEP 207-A, resulting from evaporation, had a count of 50,000 cpm (Hornbacher, D.D., Rockwell International, 1980, *Environmental Analysis Weekly Highlights Week Ending August 1, 1980*, Internal Letter to T.R. Crites, Rockwell International, August 1).

September 1980 - Cleanout of Pond 207-B-Center began with removal of sand, sludge, tar and debris. Sludge was moved to the northwestern corner of the SEP for transfer to SEP 207-A. Air monitoring prior to the start of cleanup activities indicated 0.06 pCi/m^3 total long-lived alpha (Hornbacher, D.D., Rockwell International, 1980, *Environmental Analysis Weekly Highlights Week Ending September 12, 1980*, Internal Letter to T.R. Crites, Rockwell International, September 12).

April 1981 - The ITS (a french drain system), located on the hillside north of the SEPs, was placed in service. The 6 trenches and 2 sumps were taken out of service. Liquid collected in the drain system would go to the Interceptor Trench Pump House (ITPH) and then be transferred to Pond 207-B-North. Periodically, the liquid would be transferred from SEP 207-B-North to SEPs 207-B-Center and South (Rockwell International, 1988, *Solar Evaporation Ponds Closure Plan*, July 1).

July 1981 - Isolated spots of contaminated soil were removed from the berm east of the 207-B SEPs by hand digging. Soil removal on the eastern side of the berm was complete. The north side of the berm would be worked on next (Hornbacher, D.D., Rockwell International, 1981, *Environmental Analysis Weekly Highlights Week Ending July 24, 1981*, Internal Letter to T.R. Crites, Rockwell International, July 24).

November 1981 - Approximately 1,000 gallons of sewage sludge slurry from the digester and aerator were placed in SEP 207-A after a tank truck spilled the material on the ground near the SEP. The sewage was pumped from the ground into the SEP (Hornbacher, D.D., Rockwell International, 1981, *Environmental Analysis Weekly Highlights Week Ending November 25, 1981*, Internal Letter to T.R. Crites, Rockwell International, November 30).

January 1982 - A potential nitrate runoff problem resulting from the hillside seepage below the solar SEPs was of concern. Plans were made to construct a collection trench and sump at the base of the hill (Hornbacher, D.D., Rockwell International, 1982, *Environmental Analysis Weekly Highlights Week Ending January 8, 1982*, Internal Letter to T.R. Crites, Rockwell International, January 8).

February 1982 - Plans were made to pump high-nitrate water from Basin A-3 to SEP 207-B (Hornbacher, D.D., Rockwell International, 1982, *Environmental Analysis Weekly*

Highlights Week Ending February 19, 1982, Internal Letter to T.R. Crites, Rockwell International, February 19).

Late February or April 1982 - Construction activities to expand the ITS on the southern side of the PSZ patrol road began (Hornbacher, D.D., Rockwell International, 1982, *Environmental Analysis Weekly Highlights Week Ending April 2, 1982*, Internal Letter to T.R. Crites, Rockwell International, April 2). Spraying of water from 207-B-North was conducted at a rate of approximately 89,445 gallons per acre (Hornbacher, 445 gallons per acre, (Hornbacher, D.D., Rockwell International, 1982, *Environmental Analysis Weekly Highlights Week Ending April 23, 1982*, Internal Letter to T.R. Crites, Rockwell International, April 23). [Note: The area where this spraying was taking place is now known as the West Spray Field, Operable Unit 11.] Water for application to the West spray Field was removed from SEPs 207-B-Center and 207-B-North. During the time of West Spray Field Operation, Pond 207-B-Center contained treated sanitary effluent, while Pond 207-B-North contained water collected from the ITS. (Advanced Sciences, Inc., 1991, *Solar Pond Interceptor Trench System Groundwater Management Study, Rocky Flats Plant*, Task 7 of the Zero-offsite Water Discharge Study, Prepared for EG&G Rocky Flats, Inc., January 8).

May 1982 - The new nitrate collection system near the northeastern security road was reported to be operating properly (Hornbacher, D.D., Rockwell International, 1982, *Environmental Analysis Weekly Highlights Week Ending May 7, 1982*, Internal Letter to T.R. Crites, Rockwell International, May 7).

July 1982 - Nitrate concentrations in the SEPs were as follows: 310 mg/L for Pond 207-B-North on July 6: 158 mg/L for 207-B-North on July 12; and 250 mg/L for 207-B-Center on July 12 (Hornbacher, D.D., Rockwell International, 1982, *Environmental Analysis Weekly Highlights Week Ending July 16, 1982*, Internal Letter to T.R. Crites, Rockwell International, July 16). The valve between 207-B-North and Center was repaired to prevent the accidental spraying of water from 207-B-North (Hornbacher, D.D., Rockwell International, 1982, *Environmental Analysis Weekly Highlights Week Ending July 23, 1982*, Internal Letter to T.R. Crites, Rockwell International, July 23).

1985 - Construction began on Building 788, the new storage facility for pondcrete, between SEPs 207-A and 207-C.

June 1985 - Removal of SEP 207-A sludge began.

November 1985 - Use of the West Spray Field ended (Advanced Sciences, Inc., 1991, *Solar Pond Interceptor Trench System Groundwater Management Study, Rocky Flats Plant*, Task 7 of the Zero-Offsite Water-Discharge Study, Prepared for EG&G Rocky Flats, Inc., January 8).

1986 - Placement of process waste water into the SEPs ceased due to changes in the RFP waste water treatment operations. Sludge from SEP 207-A was mixed with Portland cement and solidified as pondcrete.

October 1986 - Construction of the new pondcreting building was complete (Rockwell International, 1988, *Solar Evaporation Ponds Closure Plan*, July 1).

1988 - An addition was made to the northern end of Building 788 to increase storage capacity.

May 1988 - First spill of pondcrete occurred. This spill occurred on the 904 Pad (Rocky Flats Plant, 1988, *RCRA Contingency Plan Implementation Report No. 88-001, Rocky Flats Plant, EPA ID Number CO 7890010526*, June 7). Other spills of pondcrete occurred after this first spill.

June/July 1988 - Last process waste sludge and water removed from SEP 207-A (Blaha, F.J., Rockwell International Corporation, 1988, Internal Memorandum from F.J. Blaha to G. Hewitt, June 23; Rockwell International, 1988, *Solar Evaporation Ponds Closure Plan*, July 1).

Fall 1988 - The asphalt concrete slide slopes of SEP 207-A were relined.

August 1989 - The SEPs' Interceptor Trench Central Collection Sump Pit overflowed. The water which flowed out of the pit was not recovered, and the water that remained in the pit was pumped to Pond 207-B-North. The amount of liquid released to the environment was unknown (U.S. Department of Energy, 1989, *RCRA Contingency Plan Implementation Report No. 89-012*, Date Unknown).

March 1990 - Levels of established freeboard were exceeded in the 207-B SEPs. These levels were set to prevent overflow caused by high winds. No release to the environment occurred. To lower the water level in the 207-B SEPs, transfer of approximately 1.3 million gallons was made to SEP 207-A. The excess water in pond 207-A was then transferred to Building 374 for evaporation (U.S. Department of Energy, 1990, *RCRA Contingency Plan Implementation Report No. 90-003*, Date Unknown). The water was not transferred until the Fall of 1992.

September 1990 - Some seepage, which was not collected by the ITS because of soil blocking the gravel and disallowing collection of the material, flowed over the eastern extension of the ITPH (EG&G Rocky Flats, 1991, *Solar SEPs Interceptor Trench System Groundwater Management Study Rocky Flats Plant Site*, January 15).

September 1992 - Only limited quantities of water and sediments are present in SEP 207-A. All other SEPs have considerable quantities of water.

April 1993 - The ITS water was diverted to the temporary Modular Tank System as part of a previous IM/IRA for OU4 to facilitate pond cleanout operations (DOE, 1992a).

June/July 1993 - The 207-B SEPs were used to hold treated wastewater from hot systems operations testing of the Building 910 evaporators.

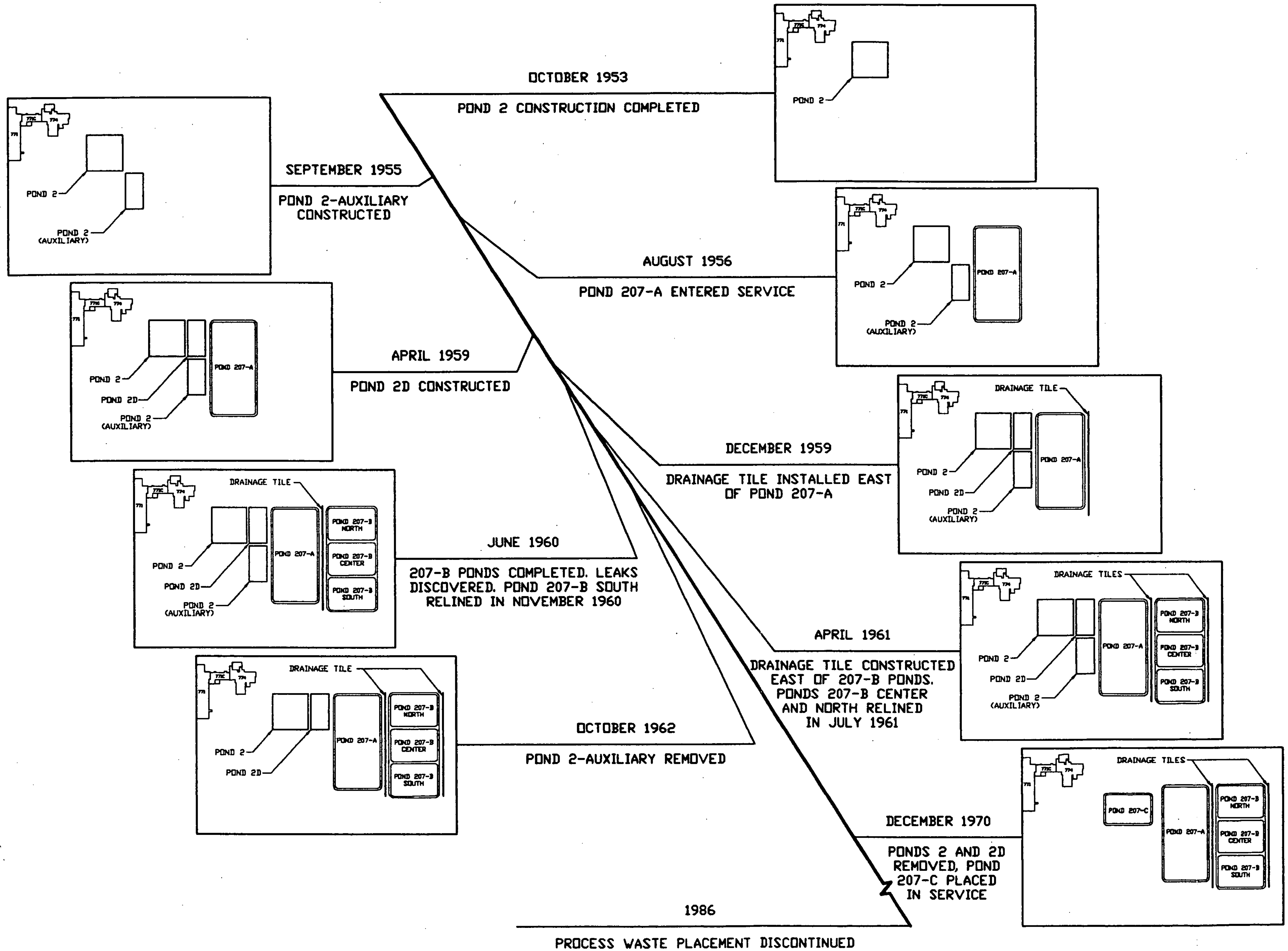

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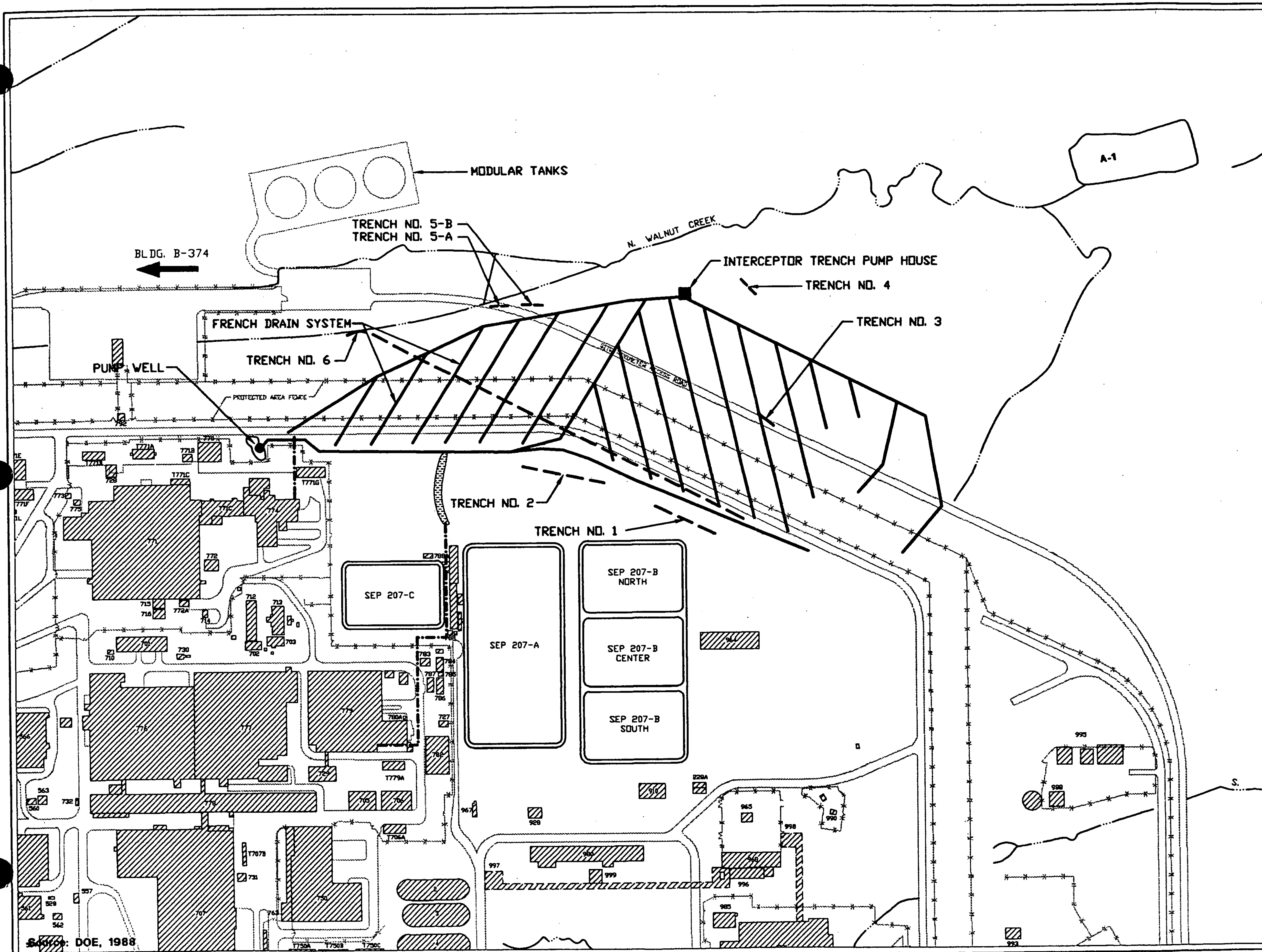
Figure I.2-3

Solar Evaporation Ponds Operable Unit No. 4, IM/IRA EA DD Chronological History of Major Pond Construction, Operation and Removal



LEGEND:

- Streams
- Paved Roads
- Buildings
- Fence
- Existing French Drain (Approximate Locations)
- Trenches (Approximate Locations)
- Footing Drains
- Drainage Ditch

100 0 100 200 300 FEET

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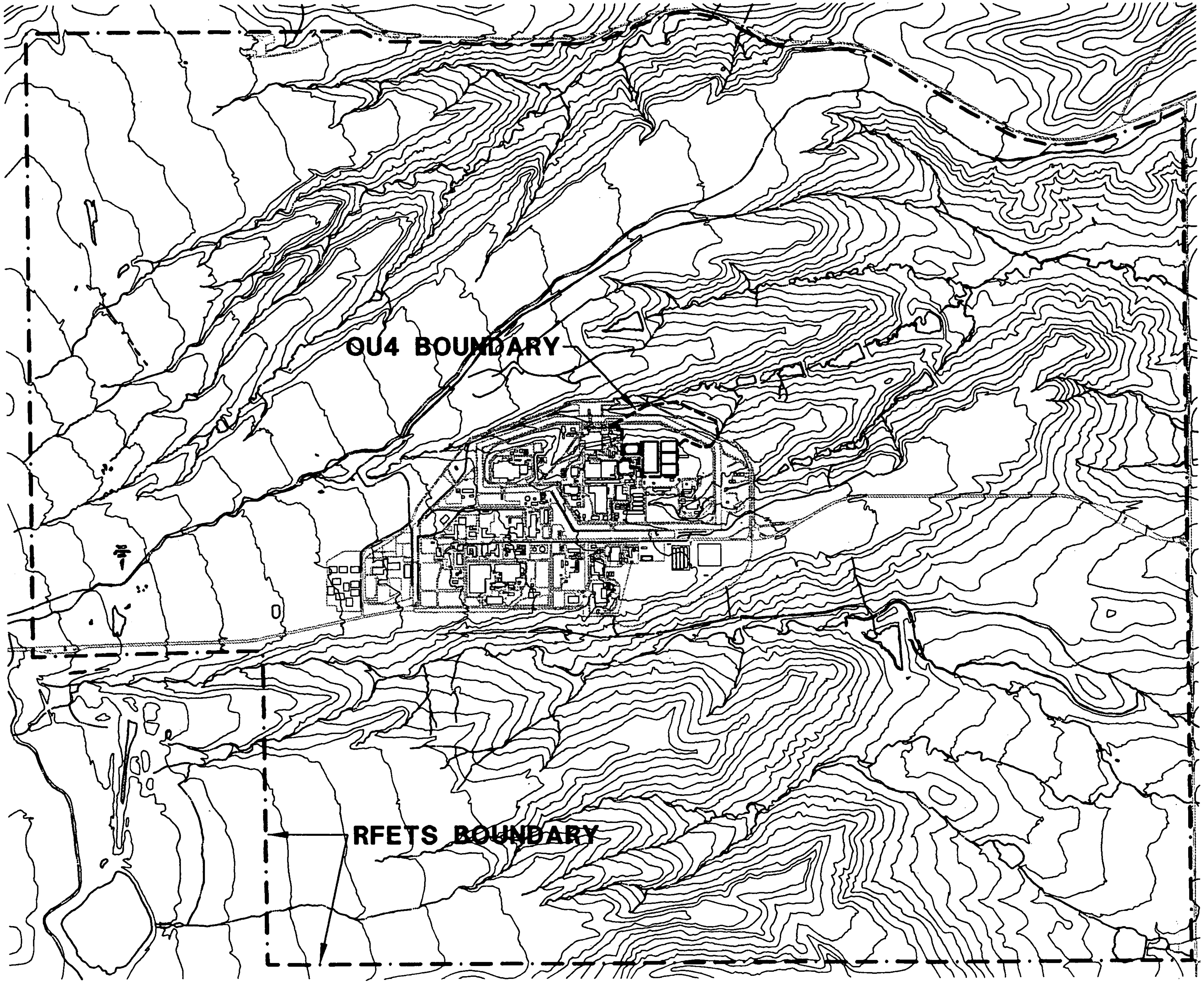
Figure I.2-4

Solar Evaporation Ponds
Operable Unit No. 4, IM/IRA EA DD
Location of Interceptor Trench System and Interceptor Trench Pump House



CONTOUR INTERVAL = 20 FEET

0 1000 2000 3000 FEET

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Figure I.4-4

Solar Evaporation Ponds
Operable Unit No. 4, IM/IRA EA DD
Topography in the Vicinity of the Rocky Flats Environmental Technology Site

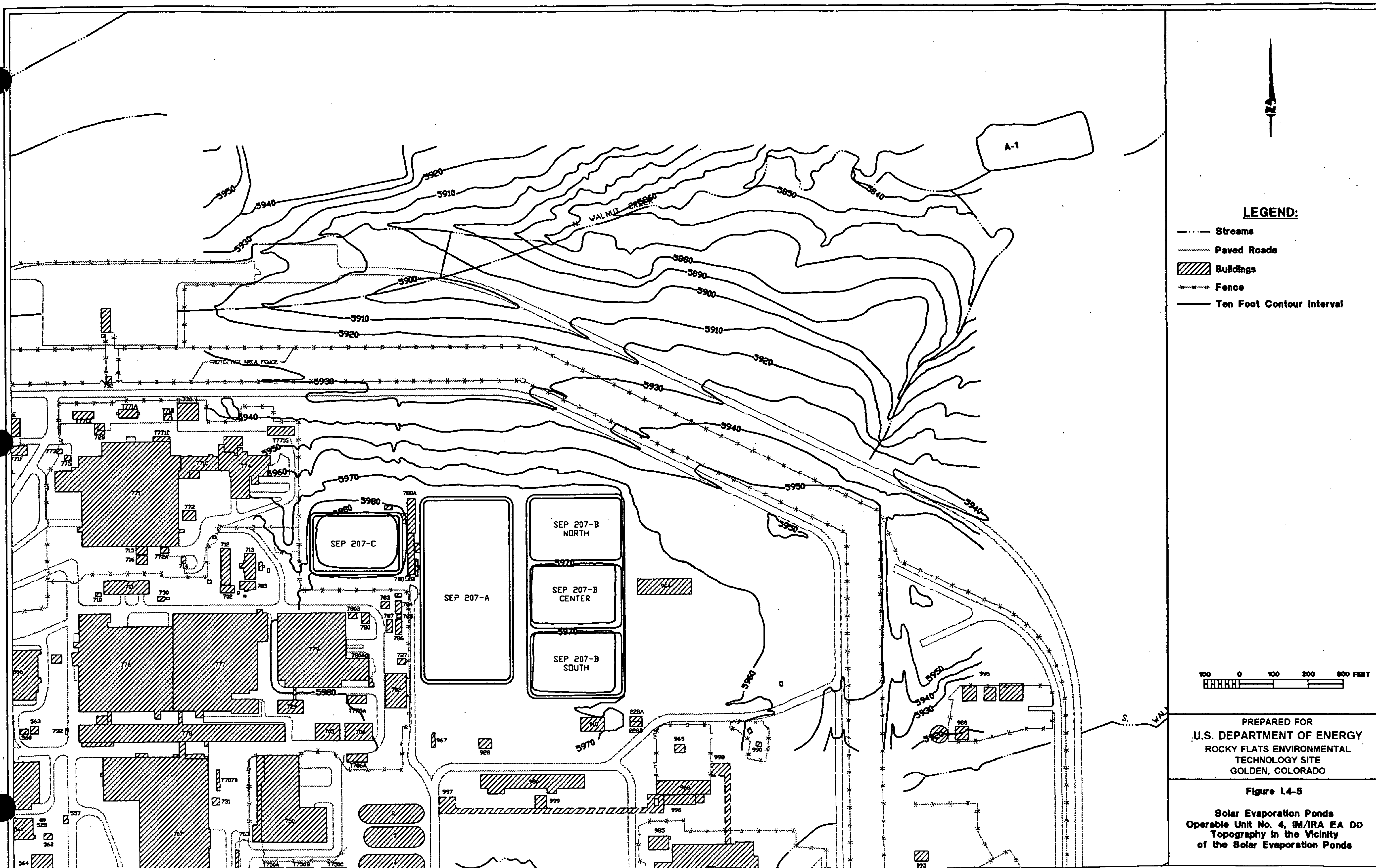
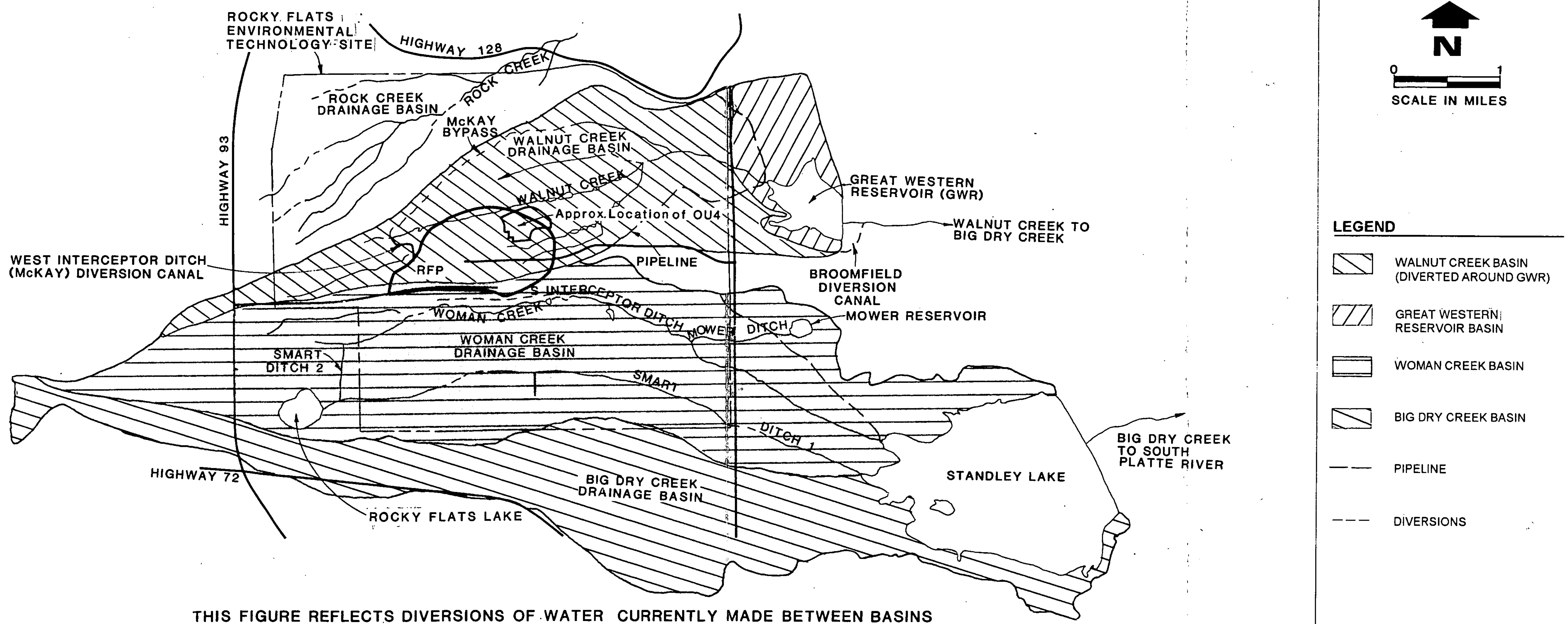


Figure I.4-5

Solar Evaporation Ponds
Operable Unit No. 4, IM/IRA EA DD
Topography in the Vicinity
of the Solar Evaporation Ponds



Source: EG&G. 1992. "Environmental Restoration Technical Support Document..."

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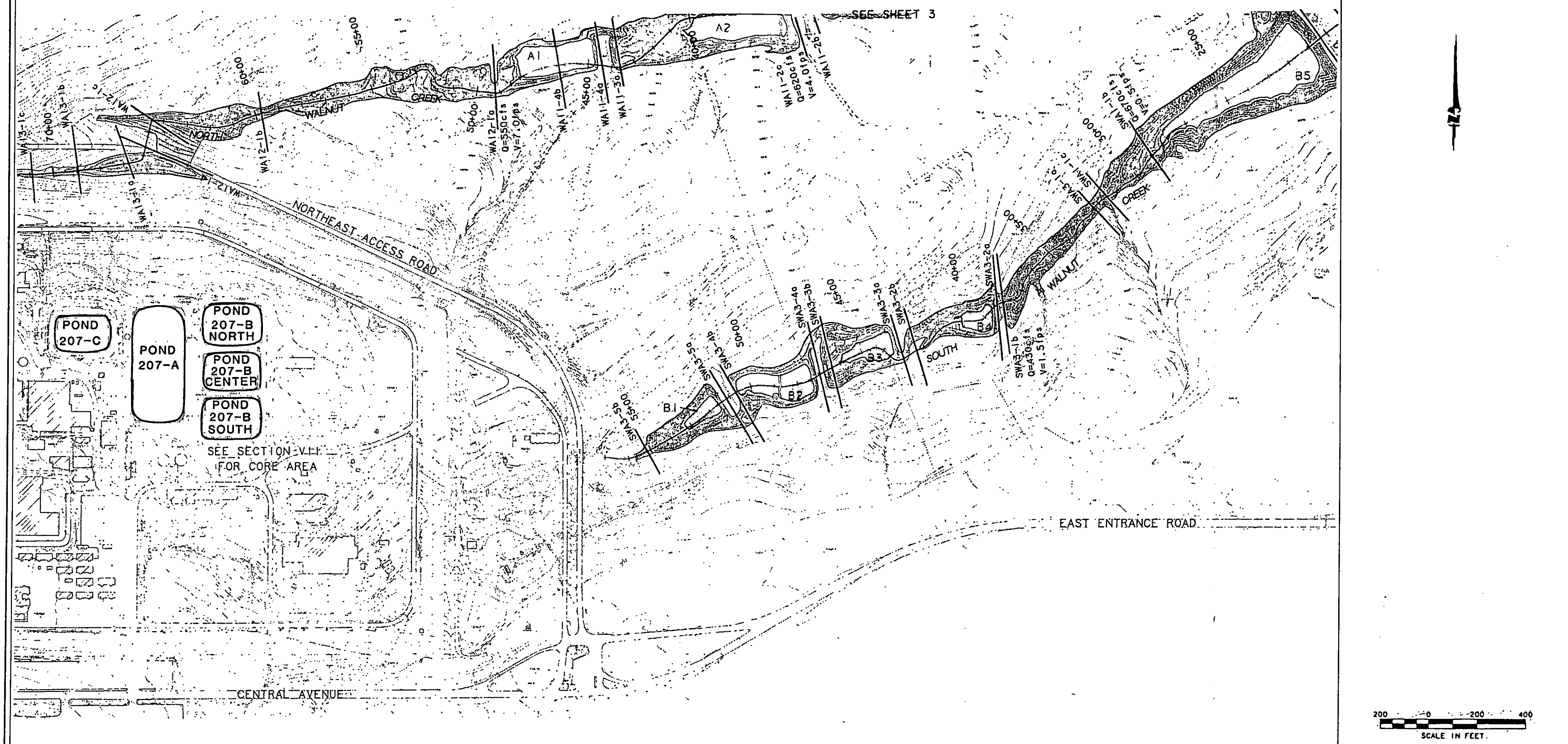
Figure I. 4-7

Solar Evaporation Ponds
Operable Unit No. 4, IM/IRA EA DD
Rocky Flats Environmental
Technology Site Drainage Basins

rf11x17



Source: EG&E, 1992e

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Figure I.4-8

OU4 IM/IRA
North Walnut Creek
100-Year Floodplain

rf11x17

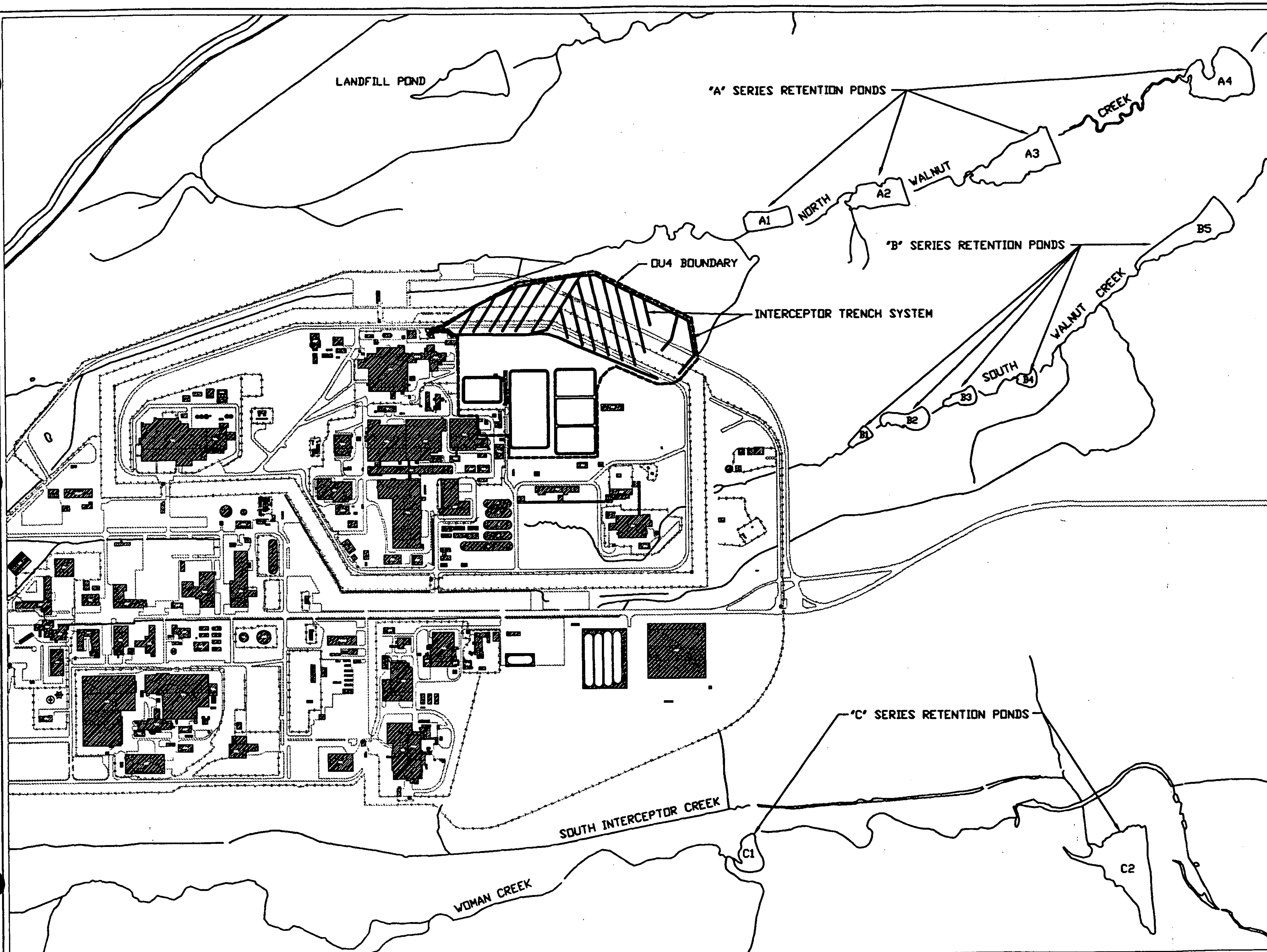

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Figure I.4-9

Solar Evaporation Ponds
Operable Unit No. 4, IM/IRA EA DD
Rocky Flats Environmental Technology Site
Retention Basins

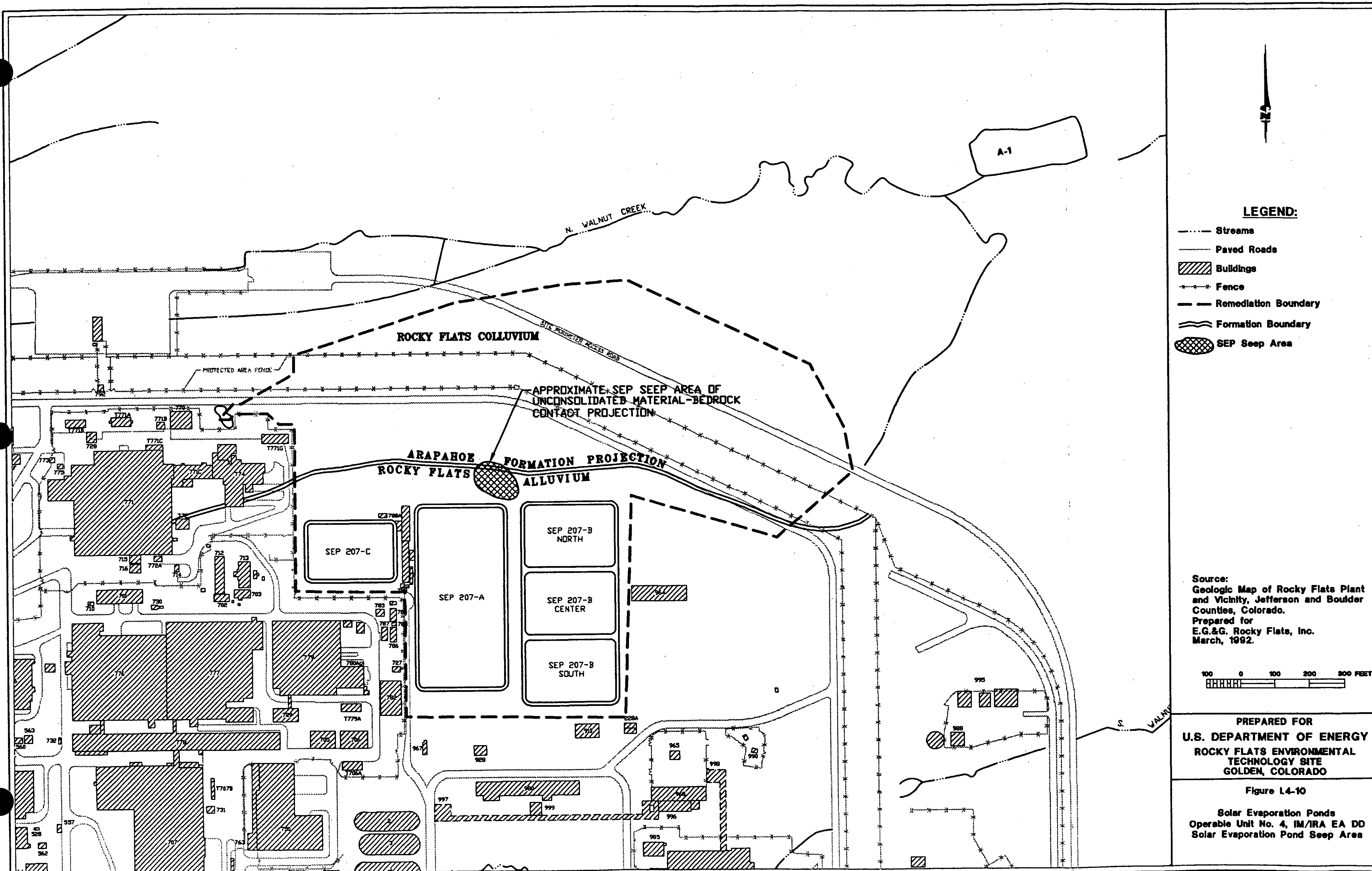

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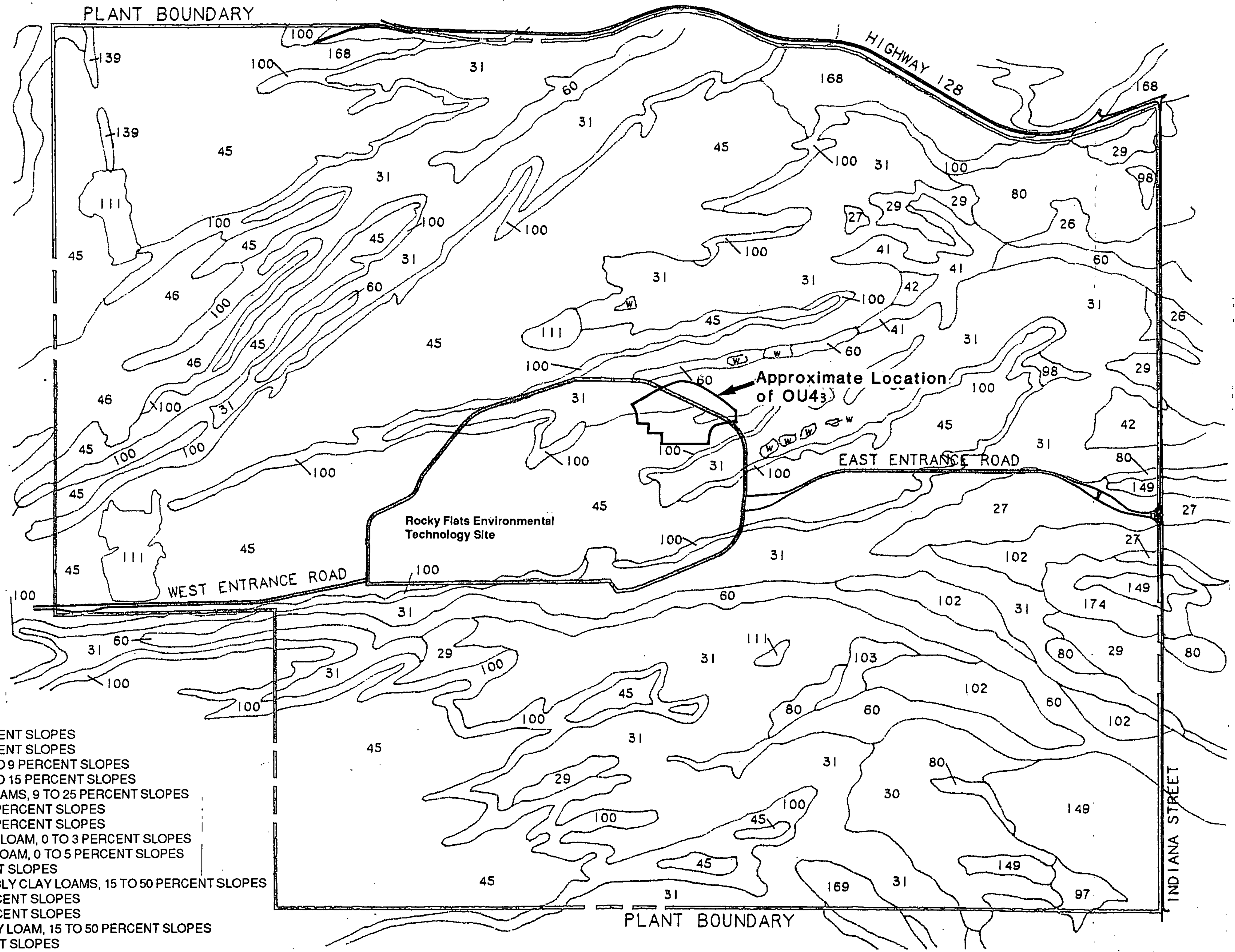
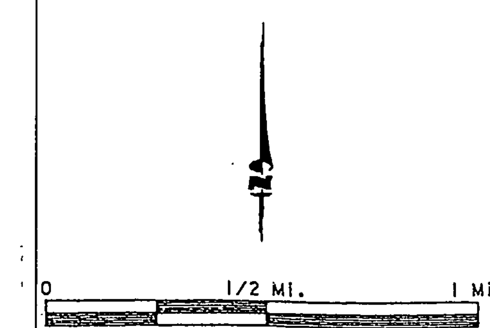
Figure I.4-10

Solar Evaporation Ponds
Operable Unit No. 4, IM/IRA EA DD
Solar Evaporation Pond Seep Area





SOIL LEGEND

26 DENVER CLAY LOAM, 2 TO 5 PERCENT SLOPES
27 DENVER CLAY LOAM, 5 TO 9 PERCENT SLOPES
29 DENVER-KUTCH CLAY LOAMS, 5 TO 9 PERCENT SLOPES
30 DENVER-KUTCH CLAY LOAMS, 9 TO 15 PERCENT SLOPES
31 DENVER-KUTCH-MIDWAY CLAY LOAMS, 9 TO 25 PERCENT SLOPES
41 ENGLEWOOD CLAY LOAM, 0 TO 2 PERCENT SLOPES
42 ENGLEWOOD CLAY LOAM, 2 TO 5 PERCENT SLOPES
45 FLATIRONS VERY COBBLY SANDY LOAM, 0 TO 3 PERCENT SLOPES
46 FLATIRONS VERY STONY SANDY LOAM, 0 TO 5 PERCENT SLOPES
60 HAVERSON LOAM, 0 TO 3 PERCENT SLOPES
80 LEYDEN-PRIMEN-STANDLEY COBBLY CLAY LOAMS, 15 TO 50 PERCENT SLOPES
97 McCLAVE CLAY LOAM, 0 TO 3 PERCENT SLOPES
98 MIDWAY CLAY LOAM, 9 TO 30 PERCENT SLOPES
100 NEDERLAND VERY COBBLY SANDY LOAM, 15 TO 50 PERCENT SLOPES
102 NUNN CLAY LOAM, 2 TO 5 PERCENT SLOPES
103 NUNN CLAY LOAM, 2 TO 5 PERCENT SLOPES
111 PITS, GRAVEL
139 ROCK OUTCROP, SEDIMENTARY
149 STANDLEY-NUNN GRAVELLY CLAY LOAMS, 0 TO 5 PERCENT SLOPES
168 VALMONT-CLAY LOAM, 0 TO 3 PERCENT SLOPES
169 VELDKAMP-NEDERLAND VERY COBBLY SANDY LOAMS, 0 TO 3 PERCENT SLOPES
174 WILLOMANN-LEYDEN COBBLY-LOAMS, 9 TO 30 PERCENT SLOPES
w SURFACE WATER CONTROL STRUCTURES (RETENTION BASINS)

Source: ASI. 1991. "The SEPs ITS Ground Water Management Study..."

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Figure I.4-11

Solar Evaporation Ponds
Operable Unit No. 4, IM/IRA EA DD
Soil Types in the Vicinity of the Rocky Flats Environmental Technology Site

rf11x17

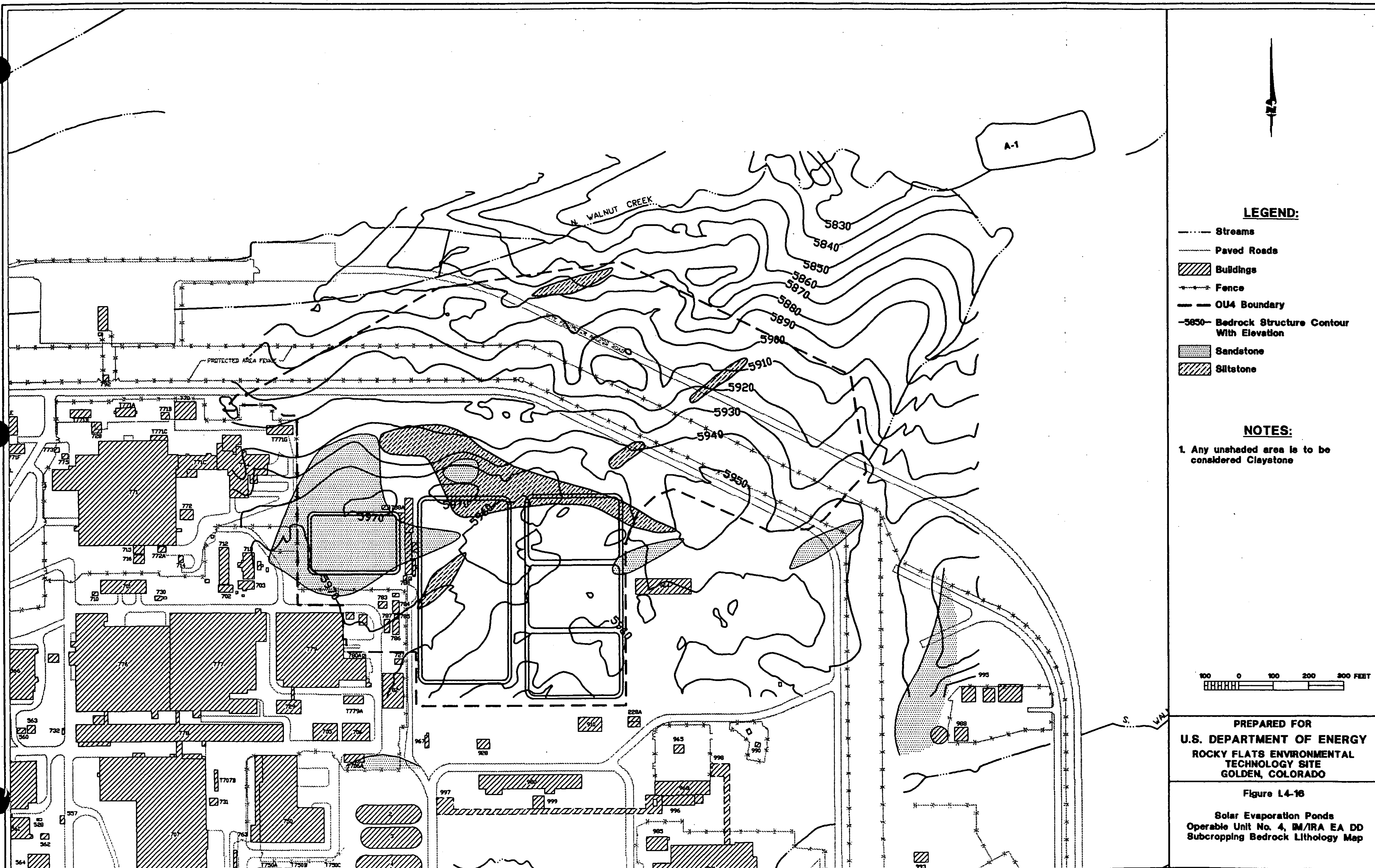
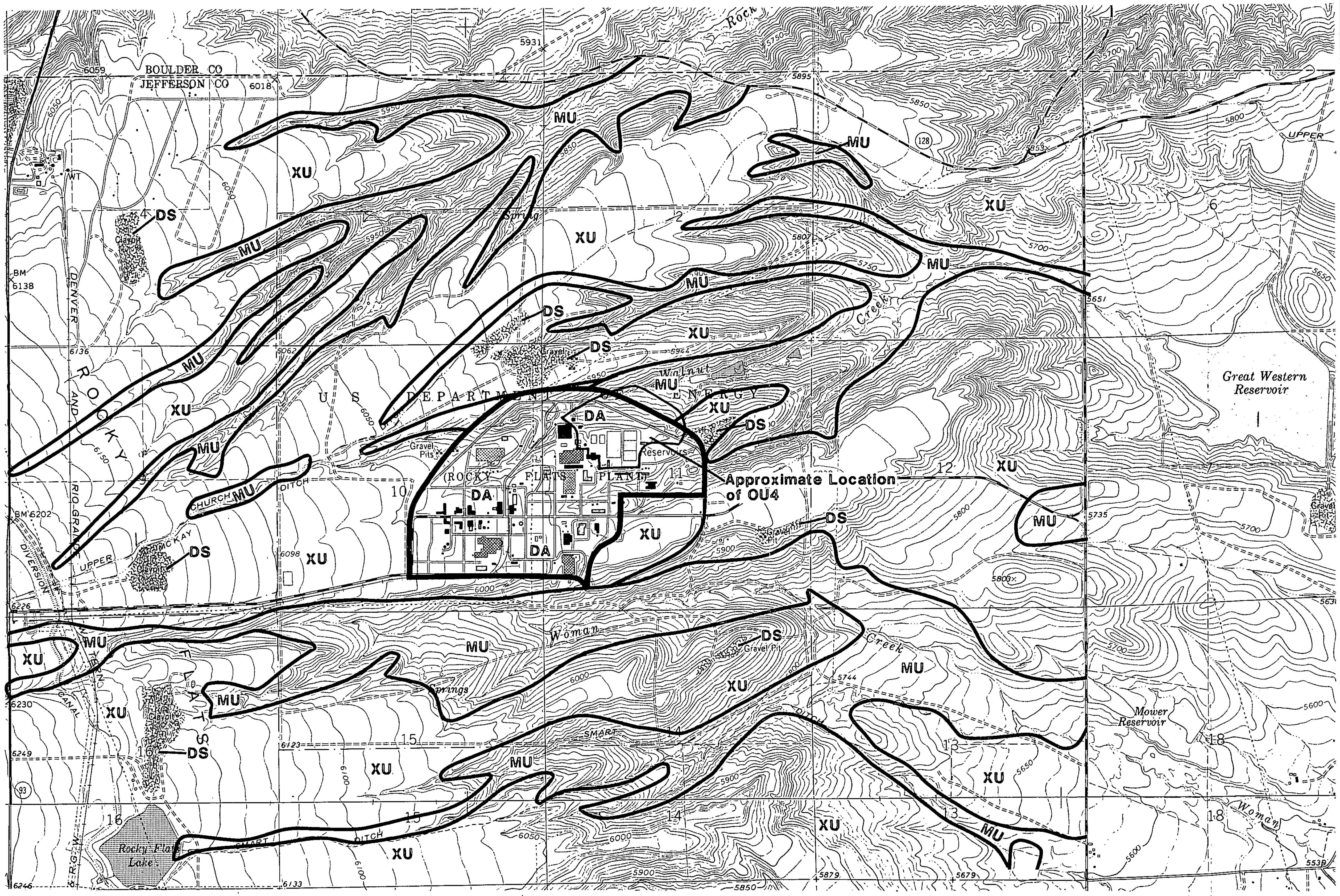


Figure I.4-16

Solar Evaporation Ponds
Operable Unit No. 4, IM/IRA EA DD
Subcropping Bedrock Lithology Map



LEGEND

XU	Xeric Upland Habitats
MU	Mesic Upland Habitats
DS	Highly Disturbed Sites
DA	Developed Areas

0 2000
FEET

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Figure 1.4-17

Solar Evaporation Ponds
Operable Unit No. 4, IM/IRA EA DD
Upland Habitats at the Rocky Flats Environmental Technology Site

Source: ASI. 1991. "The SEPs ITS Ground Water Management Study..."

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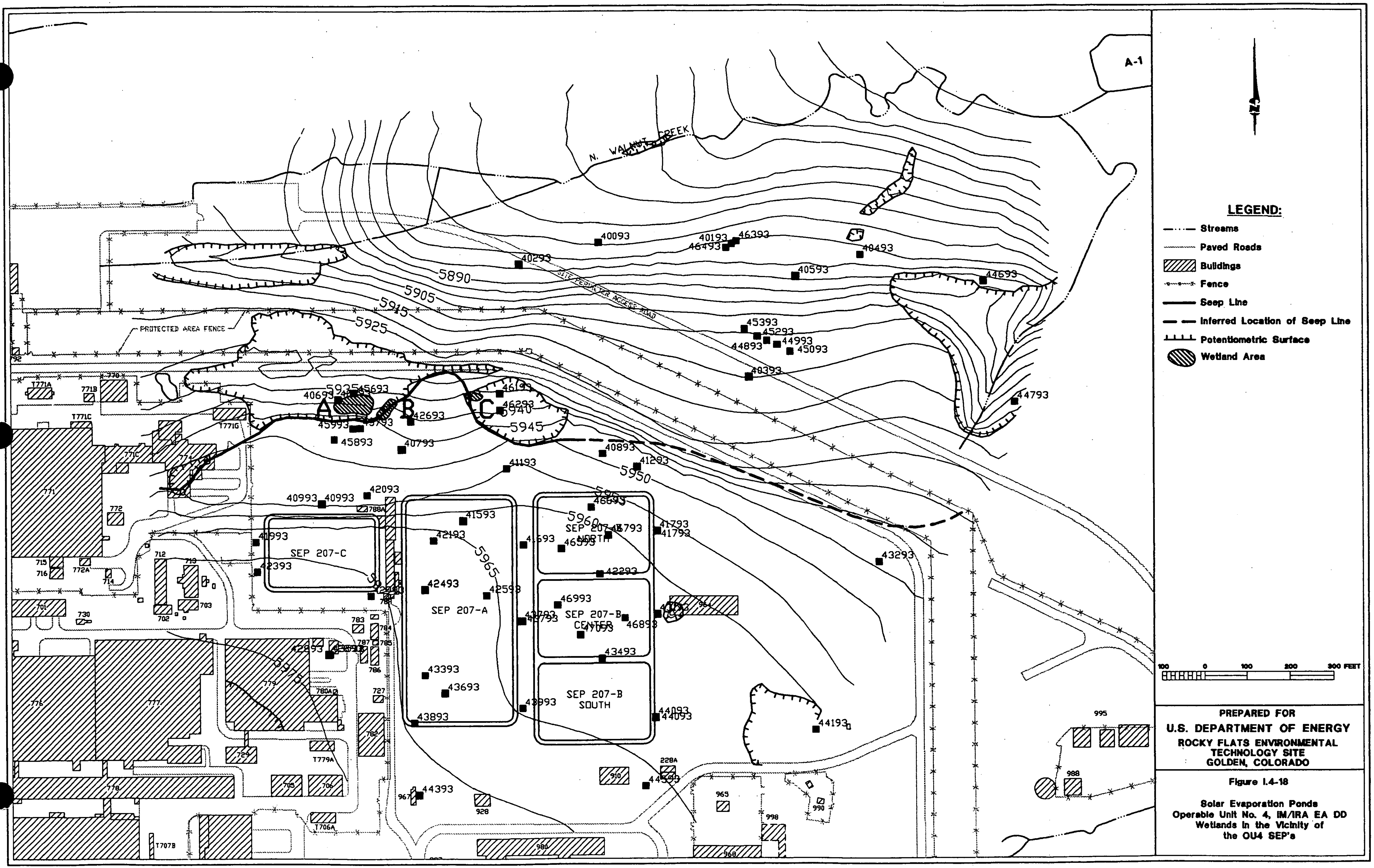

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Figure I.4-18

Solar Evaporation Ponds
Operable Unit No. 4, IM/IRA EA DD
Wetlands in the Vicinity of the OU4 SEP's